PB-229 564

# PROCEEDINGS OF THE NATIONAL CONFERENCE ON WATER POLLUTION HELD AT THE SHERATON-PARK HOTEL, WASHINGTON, D. C. ON DECEMBER 12-14, 1960

Public Health Service
Washington, D. C.

1960

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 229 564

# PROCEEDINGS

## The National Conference on Water Pollution

December 12–14, 1960
Sheraton-Park Hotel
Washington, D.C.

Public Health Service
Division of Engineering Services
Reference Room

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service

# A MESSAGE FROM THE PRESIDENT

It is a pleasure to send greetings to the citizens assembled in Washington for the National Conference on Water Pollution. It is heartening to know that this Conference has attracted such a splendid representation from across the land.

We in the United States are fortunate in having generally adequate amounts of rainfall over large areas of our country, but we waste much of this precious natural resource by water pollution. We cannot continue to do so and still have enough good water for the growing needs of our population, industry, and agriculture. Nor can we continue to expose our people to the health hazards of water pollution.

In asking the Department of Health, Education, and Welfare to call this National Conference, I stressed the mutual responsibilities of all segments of our society in cleaning up our waterways. We need appropriate action by Federal, interstate, state and local agencies. We need greatly expanded research, the continuing efforts of industry and agriculture, and, most important of all, we need the wholehearted support of the individual citizen. It is the business of the Conference to study and assess the problem of water pollution in all its aspects and to develop goals and programs that will assure progress in this field.

I am delighted to add my best wishes for a most successful meeting.

Dwight D. Eisenhower

DWIGHT D. EISENHOWER

**Preceding page blank**

# PREFACE

This volume presents the official proceedings of the National Conference on Water Pollution, called at the request of President Eisenhower and held in Washington, D.C., in December 1960.

The mission and purpose of the Conference were expressed in its official announcement, issued in the mid-summer of 1960 by Dr. Leroy E. Burney, Surgeon General of the Public Health Service:

"At the request of the President and of the Secretary of Health, Education, and Welfare, I have called a National Conference on Water Pollution to be held in Washington, D.C., December 12-14, 1960.

"Pollution is a pressing problem. It depletes one of our greatest natural resources. It is a threat to public health and to the economic and social welfare of our people. A consequence of our population and industrial growth, water pollution can be controlled, given the concerted efforts of industry, agriculture, and all levels of our government, supported by the people at large. I hope that all may be represented at the Conference.

"The purpose of the Conference will be to assess the problem of water pollution, to determine its effects upon our national welfare, and to set realistic goals for its control. In this way the Conference will create a national body of opinion and documented fact on which our country may base a new and more vigorous attack on this serious hazard

"The theme of the Conference will be 'Clean Water—A Challenge to the Nation'."

The Conference opened December 12 after more than six months of preparatory work carried on by a special Public Health Service staff assisted by a Steering Committee of distinguished private citizens. More than 1,200 persons attended the meeting, despite one of the most serious winter storms to occur in Washington in many years.

The program of the Conference consisted of a plenary session and an evening banquet on its opening day, four concurrent panel meetings on December 13, and a final plenary session on December 14, devoted to reports and summarization.

The Conference was conducted without the adoption of formal resolutions. Reports and recommendations were prepared by sub-

**Preceding page blank**

committees which were so selected as to represent all interested groups in attendance at the meetings. Following each panel session and the presentation of each summary report an opportunity was provided for discussion and questions from the floor. Participants were also invited to enter further remarks and points of view for inclusion in these proceedings.

The material in this volume is presented in eight chapters, the first seven devoted to individual sessions and the eighth to a summary of recommendations. The material is based on the formal presentations of speakers and discussants, supplemented by stenographic transcript of floor and panel discussions. Three appendixes are also provided, the first consisting of additions made to the record, the second listing exhibits and film showings, and the third naming the more than 80 Conference participants.

Among these participants, who played so great a part in the success of the Conference, are members of the Steering Committee and of the Water Pollution Control Advisory Board, the speakers and discussants who addressed the Conference sessions, the Public Health Service resource personnel who assisted in its deliberations, and the Conference staff. To all of these the Public Health Service owes a deep debt of gratitude.

Frank A. Butrico,
*Executive Secretary*

# CONTENTS

Page

**A MESSAGE FROM THE PRESIDENT** ........ iii

**PREFACE** ........ v

*Monday, December 12*

**THE OPENING SESSION** ........ 1

Leroy E. Burney, M.D.—*Clean Water* ........ 5
Albert E. Forster—*A Matter of Survival* ........ 13
Dr. Ira N. Gabrielson—*Pollution is a People Problem* ........ 23
Mark D. Hollis—*The Water Pollution Image* ........ 30

**THE BANQUET MEETING** ........ 41

***The Legislator Looks at Water Resources and Water Pollution Control*** ........ 41

Hon. Robert S. Kerr ........ 41
Hon. Francis Case ........ 42
Hon. John A. Blatnik ........ 44
Hon. William C. Cramer ........ 45

*Tuesday, December 13*

**PANEL I—Water Pollution and Our Changing Times** ........ 47

***Morning Session*** ........ 47

Hon. Thomas A. McCann—*Chairman's Remarks* ........ 47
Dwight F. Metzler—*Assessing the Water Pollution Problem* ........ 49
  Theodore M. Schad—*Discussion* ........ 57
Dr. Robert A. Kehoe—*Impacts of Pollution on Health* ........ 60
  Dr. Russell E. Teague—*Discussion* ........ 66
General Discussion ........ 70

### *Tuesday, December 13—Continued*

Page

*Afternoon Session* . . . 85

- Seth Gordon—*Impacts of Pollution on Fish and Wildlife, Recreation and Esthetic Values* . . . 85
  - Frank Gregg—*Discussion* . . . 94
  - Mrs. E. Lee Ozbirn—*Discussion* . . . 99
- L. C. Burroughs—*Impacts of Water Pollution on Industry* . . . 103
  - K. S. Watson—*Discussion* . . . 110
- Irving K. Fox—*Pollution, the Problem of Evaluation* . . . 114
  - A. J. Biemiller—*Discussion* . . . 119
- General Discussion . . . 123

**PANEL II—Meeting the Growing Competition for Water** . . . 135

*Morning Session* . . . 135

- Dr. E. A. Ackerman—*Chairman's Remarks* . . . 135
- Clarence W. Klassen—*Water Quality Management—A National Necessity* . . . 136
  - Earl C. Hubbard—*Discussion* . . . 150
- Harvey O. Banks—*Priorities for Water Use* . . . 153
  - Hon. F. G. Aandahl—*Discussion* . . . 167
- General Discussion . . . 170

*Afternoon Session* . . . 185

- T. J. Powers—*Water Quality Intelligence* . . . 185
  - Morrison B. Cunningham—*Discussion* . . . 191
- James W. Woodruff, Jr.—*River Basin and Multipurpose Planning* . . . 195
  - Eugene W. Weber—*Discussion* . . . 203
  - Hon. Clair Engle—*Discussion* . . . 206
- Carl B. Brown—*Effects of Land Use and Treatment on Pollution* . . . 209
  - Gordon K. Zimmerman—*Discussion* . . . 219
- Dr. Clarence Cottam—*Pesticides and Water Pollution* . . . 222
  - L. A. Dean—*Discussion* . . . 236
- General Discussion . . . 238

## *Tuesday, December 13—Continued*

Page

**PANEL III—Keeping Water Clean** . . . . . . . . . . . . . . . . . . . . . . . . . . . . 247

*Morning Session* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 247

Dr. Abel Wolman—*Chairman's Remarks* . . . . . . . . . . . . . . . . . . . . . . . . 247

Robert A. Forsythe—*The Needs and Obligations of Federal Agencies* . . . . 250

Edward J. Cleary—*The Needs and Obligations of Interstate Agencies* . . . . 270

Karl M. Mason—*The Needs and Obligations of State Agencies* . . . . . . . . . 277

Justus H. Fugate—*The Needs and Obligations of Metropolitan Agencies (Municipal)* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 281

M. James Gleason—*The Needs and Obligations of Metropolitan Agencies (County)* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 298

Leonard Pasek—*The Needs and Obligations of Industry* . . . . . . . . . . . . . . 309

James M. Gill—*Discussion* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 321

General Discussion . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 323

*Afternoon Session* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 329

R. G. Lynch—*Public Awareness and Citizen Responsibility* . . . . . . . . . . . 329

Mrs. Arthur E. Whittmore—*Discussion* . . . . . . . . . . . . . . . . . . . . . . . . . 337

David B. Lee—*Discussion* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 340

Frank E. Curley—*Financing Aspects of Water Pollution Control* . . . . . . . 343

Robert F. Boger—*Discussion* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 350

Chester S. Wilson—*Legal Aspects of Water Pollution Control* . . . . . . . . . 354

Richard T. Sanders—*Discussion* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 381

General Discussion . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 384

**PANEL IV—Research and Training** . . . . . . . . . . . . . . . . . . . . . . . . . . 407

*Morning Session* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 407

Dr. Erman A. Pearson—*Critical Research Needs—Environmental Aspects* . 407

Dr. Clair S. Boruff—*Discussion* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 419

Dr. John A. Zapp—*Critical Research Needs—Medical Aspects* . . . . . . . . . 424

Dr. Chauncey D. Leake—*Discussion* . . . . . . . . . . . . . . . . . . . . . . . . . . . 434

General Discussion . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 437

## *Tuesday, December 13—Continued*

Page

*Afternoon Session* ........ 452

Dr. Gordon M. Fair—*Chairman's Remarks* ........ 452

Dr. Rolf Eliassen—*Research and Treatment Technology* ........ 454

Richard Hazen—*Discussion* ........ 458

Dr. R. Keith Cannan—*Resources for Research and Training* ........ 462

G. A. Rohlich—*Discussion* ........ 469

Dr. Karl Brandt—*Water Pollution Control and Its Challenge to Political Economic Research* ........ 474

Dr. Gilbert F. White—*Discussion* ........ 485

General Discussion ........ 488

## *Wednesday, December 14*

### THE CLOSING SESSION

Harry E. Schlenz—*Chairman's Remarks, Morning Session* ........ 498

Panel I—Report and Discussion—Hon. Thomas A. McCann ........ 499

Panel II—Report and Discussion—Dr. E. A. Ackerman ........ 504

Panel IV—Report and Discussion—Dr. Gordon M. Fair ........ 518

John S. Samson, *Chairman's Remarks, Afternoon Session* ........ 529

Panel III—Report and Discussion—Dr. Abel Wolman ........ 531

Stuart Finley, *Summarization of Conference* ........ 548

Hon. Arthur S. Flemming, *Federal Role in Pollution Control* ........ 556

Leroy E. Burney, M.D.—*Closing Remarks* ........ 563

RECOMMENDATIONS OF THE CONFERENCE ........ 564

**APPENDIX I—Additions to the Record** ........ 573

**APPENDIX II—Conference Exhibits and Film Showings** ........ 598

**APPENDIX III—Conference Participants** ........ 601

A. Steering Committee ........ 601

B. Water Pollution Control Advisory Board ........ 602

C. Participants and Speakers ........ 602

# OPENING PLENARY SESSION

*Monday, December 12*

**The Opening Plenary Session of the National Conference on Water Pollution was convened at 2:00 p.m., following a four-hour delay because of the heavy snow on the eve of the Conference which prevented many delegates from arriving in Washington on schedule**

***Chairman***
**Gordon E. McCallum, *Chief***
***Division of Water Supply and Pollution Control***
***Public Health Service***

## Opening Statement

**Dr. Leroy E. Burney**
***Surgeon General, Public Health Service***

I take great pleasure this afternoon in welcoming you to the National Conference on Water Pollution. I am also pleased to read the following message to the Conference from President Eisenhower: [Editor's Note—The welcoming remarks by the President appear on Page iii of this document.]

You have come here from all parts of the country. You represent many different interests, many different professions, many different points of view. But by your attendance here all of you are demonstrating that you have one thing in common. That is your deep concern over the seriousness of the pollution of the watercourses of the United States and the manifold problems to which this pollution gives rise.

We in the Public Health Service share that concern. We have called this Conference in the belief that those of you here today and the organizations you represent will join with us in launching a new national effort to deal with the water pollution problem. To this effort I pledge my wholehearted personal support and the full resources of the Public Health Service.

I suspect that never before has so much professional knowledge and technical skill on water pollution been assembled under one roof. Equally important and valuable is the presence of so many persons representing consumer groups, people who view water pollution from the standpoint of health, of conservation, of recreation, of agriculture, of industry. The problem before us demands all the professional resources and all the enlightened participation and support of the public that we can muster. I am most happy to see all these interests so well represented here.

This Conference has an historic mission—to set the guidelines for a national water pollution control policy suited to our times, a policy bold enough to meet the challenges posed by the transformation of our environment through growth and technological advance. By taking part in the deliberations of this Conference and in helping to shape its recommendations, you merit the gratitude of the Nation.

I have the highest hopes and greatest expectations for this National Conference on Water Pollution. Before discussing these hopes, and describing some of the activities already underway which serve as a background for your deliberations, I should like to acknowledge the indebtedness of the Public Health Service to a number of individuals whose thoughtful guidance and tireless efforts have made this Conference possible. I refer to the members of the Conference Steering Committee who have done an outstanding job. I want to express my personal thanks to each of you for the generous measure of time and counsel which you have given to the realization and organization of this Conference.

Also, much credit goes to Frank Butrico, Executive Secretary of the Conference, for his work in organizing and planning the Conference program.

Next, it is my privilege and honor to introduce to you, individually the members of a group which has been of immeasurable help to the Public Health Service throughout the years, in our efforts to meet our responsibilities for curbing water pollution. These gentlemen, all of whom serve by appointment of the President, are the members of our Water Pollution Control Advisory Board.

It is important for me to add, at this point, that the members of the Advisory Board have unanimously accepted my invitation to take a leading part in the implementation of the recommendations that come out of this Conference. Thus, their work is closely interwoven with yours, and will continue throughout the critical period after the Conference when what we say here is translated into effective action.

I should like first to introduce the two newest members of the Board. The first, Dr. Clair S. Boruff, who is Technical Director of Hiram Walker and Sons. He holds a doctorate in philosophy from the University of Illinois. He has served as chief research chemist of the Illinois State Water Survey and at present is serving as the industry representative on the Illinois State Sanitary Water Board.

He has been a consultant to many large industries concerned with the disposal of wastes and is the author of several articles and books in this field. He was appointed to the Board by the President earlier this year.

Our second new member is a Texan—the Honorable Thomas A. McCann. He is a man of experience in the fields of construction, finance, ranching, and community service. His appointment to the Board this year recognized his long and active interest in water pollution abatement in his own and neighboring States. He is now serving his second term as Mayor of Fort Worth. In addition to his official duties as Mayor, he is the president of the McCann Construction Company and is a director of several financial institutions. He owns and operates large ranching interests in Texas. We welcome his wise counsel and advice.

The next gentleman I should like to introduce is John Charles Daly. Mr. Daly holds virtually every major award that is given for distinguished radio and television reporting. A CBS radio reporter and commentator for 12 eventful years, he joined ABC in 1949 and in 1953 became Vice President in Charge of News, Special Events, and Public Affairs—a post from which he has recently resigned.

He has served as Washington correspondent, White House correspondent, foreign correspondent, and combat reporter during World War II. He conducts news commentaries five evenings each week on both TV and radio, and is also a roving newsman on major national and international stories. In spite of these heavy responsibilities in his chosen field, John Charles Daly has found time since his appointment last year to serve as a member of the Water Pollution Control Advisory Board.

The profession of public health is represented on the President's Board by only one member, Dr. Russell E. Teague. Dr. Teague has for more than 30 years been identified in leadership roles with various public health agencies. He holds a medical degree from the University of Louisville School of Medicine and a Master of Public Health degree from The Johns Hopkins University School of Public Health.

From 1951 to 1956 he was State Health Officer for the Commonwealth of Pennsylvania. During that time he was also chairman of the State Sanitary Water Board and a member of the State Water Power Resources Board of Pennsylvania. Since 1956 he has been Commissioner of Health for the State of Kentucky. He is a member of the Kentucky Water Pollution Control Commission and past chairman of the Ohio River Valley Water Sanitation Commission. Dr. Teague was appointed to the President's Board last year.

Since 1958 the Board has had the counsel and advice of one of the country's most distinguished conservationists, Mr. Seth Gordon. Mr. Gordon began his conservation career in 1913 with the Pennsylvania Game Commission and later became its Director. In 1948 he resigned to become consultant to the California Wildlife Conservation Board. In 1951 he was appointed by Governor Warren as Director of the newly organized California Department of Fish and Game, a position he held until last year, when he returned to conservation consulting work. During the time he was Director of the California Department he also served as a member of the California Water Pollution Control Board.

He has served with numerous conservation organizations throughout the country, such as the North American Wildlife Foundation, the International Association of Game, Fish, and Conservation Commissioners, the Forest Research Advisory Committee, the Wildlife Management Institute, the Izaak Walton League of America, and the Outdoor Writers of America.

We are proud to have had on our Board since 1958 a representative of the Rocky Mountain States and of its frontier tradition, Mr. Frank E. Long. Mr. Long is a rancher, a businessman, and a notable civic leader. He is President of the Wyoming Stream Pollution Control Advisory Council. He has in the past been President of the Wyoming Livestock and Sanitary Board, the Wyoming University Planning Board, the Wyoming Association of Realtors, and of the Wyoming Beef Council. He is also a member of the Federal Land Bank Loan Board, of the American Cattlemen's Association, and of other organizations too numerous to mention.

Our representative from the Middle West on the President's Board is an old friend to those interested in conservation and the abatement of water pollution, Mr. John S. Samson. Mr. Samson is a practicing attorney in Omaha, Nebraska. He received his law degree from Creighton University Law School in Omaha. He is Chairman of the Water Pollution Control Council for the State of Nebraska. He has served for the last six years as Chairman of the Water Pollution Control Committee of the Nebraska Division of the Izaak Walton League of America.

Having acted as consultant to the Nebraska State Legislature on stream pollution abatement, Mr. Samson was appointed by Secretary Flemming to the Hearing Boards on pollution of interstate waters held at Sioux City, Iowa, and St. Joseph and Kansas City, Missouri. All three Hearing Boards were concerned with pollution of the Missouri River.

The Board member who speaks with special concern for the New England States also speaks from a lifetime of professional preoccupation with the field of water resources. He is William S. Wise. Mr. Wise is Director of the Water Resources Commission of the State of Connecticut. He is a member of the Interstate Sanitation Commission, the New England Interstate Water Pollution Control Commission, the Northeastern Resources Committee, and the Executive Committee of the Interstate Conference on Water Problems.

In addition he has served as Regional Director of the National Rivers and Harbors Congress, President of the New England Sewage and Industrial Wastes Association, and President of the Federation of Sewage and Industrial Wastes Association. In 1956 Mr. Wise received the Engineer of the Year award from the Connecticut Society of Professional Engineers.

# Clean Water

Dr. Leroy E. Burney

***Surgeon General, Public Health Service***

This Conference is one of many heartening indications that the American people are coming to a full recognition of the realities of our technologic age. To a far greater extent than ever before, we live in a man-created and man-controlled environment. It is within our power to shape our own future, to guide the evolving patterns of society and determine the nature of the surroundings in which we and our children will live.

This is a limitless opportunity. It is an awesome responsibility. It implies the adjustment of the environment to man's highest aspirations and needs, and not merely the adjustment of man to the environment. Meeting this challenge of guiding change will require imaginative and courageous thought, and equally imaginative and courageous action, for the sake of the society we seek to create.

Few if any problems are more intricately interwoven into the fabric of our society than the control of water pollution. Clean water is essential to life itself; it is essential to our industrial technology, and to agriculture; it is essential to the conservation and use of the many natural resources upon which the richer life depends.

Indeed, the water pollution picture is so vast, and its implications extend to so many aspects of the Nation's life, that each of us tends to see clearly only that portion of it which is visible through his own particular window. I thought, therefore, that it might be helpful if I were to sketch out for you, in very broad strokes, the view of the water pollution problem from the national window of a Federal agency charged with rather far-ranging responsibilities in this field.

In doing so, I should like to develop four principal points:

First, that water pollution control is an integral part of the broader problem of water resource development and use;

Second, that water pollution control is an inseparable part of the broader problem of environmental health protection;

Third, that an impressive amount of productive activity is already underway in controlling water pollution;

And fourth, that the problem demands a still stronger effort on the part of Federal, State, and local authorities, industries, and all others concerned.

### Pollution Control as an Economic Imperative

The first of these four generalizations is probably the one that is least in need of detailed elaboration before a group such as this. All of you are well acquainted with the overwhelming statistics on water usage, both today and in the foreseeable future. The volume of fresh water used daily in the United States has increased seven-fold since the turn of the century; more incredible still, it has virtually doubled since 1945, the peak year of industrial effort in World War II. And all the experts confidently predict more of the same. By 1980, according to reliable projections, our fresh water needs will have doubled again, reaching the astronomical figure of 600 billion gallons a day. A week's ration of water, at this rate, would submerge Manhattan Island to a depth of 1,000 feet.

Meanwhile, of course, the bountiful natural supply on which we must draw remains constant over the years. It is on this fixed fresh water supply that the continued growth and prosperity of the United States depends.

Water, in ever-increasing quantities, is indispensable to industry. It is indispensable to agriculture. Our fish and wildlife resources depend upon it, as the recreational facilities without which our national life would be inexcusably impoverished. Already, in many areas, there is not enough water to go 'round. To cite one outstanding example, it is estimated that the water in the Ohio River, at times of low flow, is used almost four times as it flows from Pennsylvania to the Mississippi.

It is at this point of re-use, of course, that the threads of water quality and water quantity become inextricably interwoven. And it is at this point also that considerations of national health enter the equations.

### Water Pollution Control as a Biological Imperative

There is no room for doubt that we are presently passing through a second industrial revolution, the impact of which may well surpass that of its predecessor in the 18th and 19th centuries. Like its predecessor, the second industrial revolution has thus far yielded a harvest of mixed blessings. Its synthetic products and high-energy technology promise material standards of living far beyond the rosiest dreams of our parents' generation. At the same time, its by-product wastes and side effects threaten a new kind of health problem for our own and future generations. I am referring, of course, to the environmental pollutants and conditions to which we are continuously exposed on every day of our lives—the chemicals in the water we drink, the food we eat, and the air we breathe, plus ionizing radiation from both natural and man-made sources. In essence, we are in the process of creating a new chemical and physical environment whose health implications must be explored.

I do not intend to suggest, of course, that our microbiological problems are solved, once and for all. Indeed, the population growth and metropolitan expansion which characterize our time serve to aggravate and complicate the traditional problems of environmental health protection. Water supply intakes and sewage outfalls are wedged closer together. Heavier demands are placed upon both sewage treatment and water purification, as one city draws its water supply chiefly from another city's wastes.

I do wish to emphasize, however, that in the public health professions we stand at the microchemical and microphysical frontier. Beyond this frontier are vast, uncharted areas which can only be explored through research. We already have enough information to know, however, that this exploration is urgently necessary.

We know, for example, that highly toxic chemicals are present in water in low concentrations. None of these additives improves the water, and some may damage the consumer. Some of these chemicals—chlorophenol, for instance—cause taste problems at the almost incredible dilution of one part per billion. Endrin, a chlorinated insecticide, kills fish at this level of dilution.

We know that the biological effects of some chemicals in our environment, and of low-level radiation, may build up over long periods of time. The hazard to the individual may well be related to the cumulative total of radiation or toxic chemicals received throughout his lifespan, continuously or intermittently, whether their source be water, air, food, or any of several others. A substance like lead, for example, coming from such sources as agricultural sprays and automotive exhausts, is present in food, water, air, and tobacco.

In short, the effect on human health of the contemporary environment cannot be neatly packaged in mutually exclusive categories labelled water pollution, air pollution, radiation, occupational health. The individual's health is, at root, indivisible. The total environment has a cumulative impact upon it.

## Progress in Pollution Control

This concern with a total environmental impact, primarily chemical and physical in nature, represents a dramatic change from the Public Health Service's earliest involvement in water pollution when, in 1913, a Stream Investigations Center was established at Cincinnati to conduct surveys and studies associated with waterborne disease. This small unit, the humble forebear of the present Robert A. Taft Sanitary

Engineering Center, was concerned chiefly with accumulating basic knowledge on organic pollution. The orientation was strictly microbiological, and the scale was very small.

By contrast, the present Center is the largest research enterprise of its kind in the world. Among the recent accomplishments of its team of physicians, engineers, chemists and other specialists has been the development of new and extremely sensitive devices to extract and identify organic compounds in extremely small amounts. As an illustration, a benzene derivative was found in the Mississippi River at New Orleans and traced 1,000 miles upstream to its source.

Other developments at the Center include new criteria for using sand filters in water treatment plants, and a successful pilot project of a sewage treatment procedure applicable to housing subdivisions beyond the reach of metropolitan sewer systems. Among the basic problems now under study are methods of identifying compounds present in wastes and determining whether or not these compounds can be successfully assimilated by the treatment plant or the stream. Other research involves methods of freeing water supplies from viruses and bacteria, detergents, insecticides, radioactive contaminants, and other substances which can make water unfit or unsafe.

We recognize, of course, that even this greatly accelerated research effort is only a beginning. Research must be expanded and diversified many fold, not only in Public Health Service installations but also at universities and other research centers throughout the land.

Nevertheless, the impressive growth of our Center in Cincinnati is representative of the increasing scale and diversity of Public Health Service activities in water pollution control. As most of you know, the Water Pollution Control Act of 1948 gave strong impetus to the Service's program in this area by delineating the principle of Federal-State cooperation and providing for a Federal role of research, technical assistance, limited authority over interstate waters, and financial aid. This authority was further extended in 1956, adding the principle of Federal grants to municipalities to aid in construction of sewage treatment works.

Without attempting to present a comprehensive summary of our stewardship, I should like to touch upon a few of the highlights of pollution control activity in recent years, both within the Service and across the Nation.

## Basic Data

The Public Health Service has initiated a long-range basic data program which includes: (1) A national network of 75 stream sampling stations, to be increased eventually to 300, on interstate streams to measure water quality; (2) Inventories of water, sewage, and industrial waste facilities in the United States, published at regular intervals; (3) Compilation of data on contract awards for water facilities, sewers, and sewage treatment facilities to show progress made in meeting the Nation's needs; and (4) Economic studies to find ways of determining what pollution is costing the American people and the cost-benefits of controlling it.

The national network of water sampling stations is operated by the Public Health Service in cooperation with local agencies and is supplemented by several hundred stations operated by Interstate, State and local agencies. Collected samples are examined for coliform bacteria, aquatic organisms, radioactivity including Strontium-90, synthetic organic chemicals, and for various other substances.

## Interstate Enforcement

Where pollution of interstate waters endangers the health or welfare of persons in a State other than the one in which the pollution originates, the Surgeon General and the Secretary of Health, Education, and Welfare are empowered to take action to abate pollution. Each step in the procedure is taken only if the previous one has not been effective. In only one instance, to date, has Federal court action been necessary. This was at St. Joseph, Missouri, within recent weeks.

Convincing evidence that this is a proper concern of the Federal Government, and one in which it can act effectively, was furnished last month when four major cities voted to spend a total of more than $100 million to comply with water pollution control schedules established under these enforcement provisions.

Enforcement actions have been taken thus far in 13 interstate pollution situations. Involved is the abatement of pollution in more than 4,000 miles of interstate streams. The Public Health Service estimates that the remedial measures agreed upon will include the construction of some $500 million worth of waste treatment facilities. The Service maintains files on some 2,000 interstate pollution problem areas.

## Construction Grants

Probably the best known section of the Federal Water Pollution Control Act is that which authorizes grants to cities to aid in the construction of sewage treatment plants.

Nationally, a total of 2,483 sewage treatment projects have been approved for Federal construction grants from 1956 through November 30, 1960. Of these, 1,246 are completed, 717 under construction, and the rest are awaiting construction. They received grants of $205 million, and the total project costs were $1.2 billion. In single words, these Federal incentive grants have generated an average of $5 in local expenditures for every $1 of Federal money granted. The stimulating effect of the Federal grants is further seen in the better than 64 percent rise in sewage treatment plant construction since the grant funds became available. Nevertheless, an enormous amount of construction remains to be done, especially in the metropolitan areas where two in every three Americans live. We are far, far behind in construction. It is estimated we will need to expend $600 million per year for the next eight years merely to catch up.

### Program Grants

The Federal Water Pollution Control Act authorizes $3 million a year for five years as grants to support State and interstate pollution control programs. The States are required to pay from one-third to two-thirds of the costs of these programs. In general, the States have been able to expand their operations as a result of the grants by employing additional personnel and installing special laboratory and field equipment. Some have initiated new research and stream surveys. Appropriations by the States for water pollution control activities have risen from $4.2 million (in 1956) to $6.5 million (in 1959) since the program grants became available.

The Public Health Service is proud of its long tradition of close and effective working relationships with the States. In pollution control, as in many parallel fields, theirs is the primary legislative responsibility. A first concern of our program is to strengthen their activities in all possible ways.

These matching program grants are essential in strengthening State and local programs. They are a fine example of sound State-Federal partnership.

### Training

The Public Health Service offers advanced training for engineers, chemists and other scientists and technicians from Federal and State agencies, municipalities, industries, and foreign countries. This training program, a major portion of which is conducted at the Sanitary Engineering Center, is another of the battery of technical services designed to aid the States and other allied agencies and organizations in developing their pollution control programs.

### Reorganization

The Public Health Service is presently undergoing a major reorganization, the principal purpose of which is to build strengthened programs to deal with the two major health challenges of the coming years—environmental health, and provision of community health services. When, and if, legislative approval is obtained, the new Bureau of Environmental Health will take its place beside the three existing Bureaus of the Service. Already our programs in water, air, radiation and occupational health, all recently raised to Division status, are operating as a coordinated, mutually supporting unit. These environmental health components share many aspects in common, including various research and sampling techniques and methodology, and benefit greatly from this combined approach. We consider the expansion of our environmental effort in research, technical assistance, monitoring and control as an imperative if we are to carry out our public health mission.

## The Shape of the Future

There has been genuine progress in pollution control. There has been a heightened willingness on the part of the many agencies and groups concerned to assume their rightful responsibilities. In short, there is cause for encouragement.

There is not, however, cause for complacency. The condition of our waters is a national disgrace. It is tragic for the world's richest, most powerful and most technologically advanced Nation to foul its own nest, limit its own growth, and threaten the health of its people.

It seems to me that the key word in your deliberations during the next three days is "balance"—balance in our use of water resources; balance in environmental health which permits maximum development at minimum hazard; balance in the apportionment of responsibilities, distribution of costs, and application of regulations.

Striking these balances and maintaining them are tremendous challenges. Obviously the most delicate of all will be in the area of responsibilities in the multilayered, interwoven economic and administrative world of today.

Plainly, the most fundamental responsibility of all rests at the source—with the municipalities and industries concerned. Our success or failure in pollution control will be proportional to the application of control measures by those who discharge wastes to the waters.

Clearly, too, the States must continue to be keystones of our pollution control efforts. Historically, legislatively and logically the strength of the State agency is a major determinant of success in pollution abatement.

Finally, there is an unmistakable Federal concern and responsibility derived from the national scope and enormous complexity of the problem itself—a responsibility for leadership in research and investigation, for contributing to an enlightened awareness on the part of both the public and the professions involved, for aiding and strengthening programs at State and local levels.

There are searching questions still be be answered in water pollution control. Among the many which I hope this Conference will consider are the following:

1. What are the research areas of most urgent need? What levels of financial support are needed, and who should provide it?

2. What new parameters do we need in order to obtain a true picture of water quality in a stream?

3. What shall be our national policy on the utilization of our streams for waste disposal?

4. How much shall we spend in controlling pollution, and how should these costs be apportioned? How do these costs compare with the costs of neglect? The total cost will be great, but so are the capacities of an active, inventive people.

5. What steps shall be taken, and by whom, when justly apportioned responsibilities are not met?

I said a little while ago that I have high hopes for this Conference. They are based on the assumption that we can, collectively as a mixed enterprise, hammer out hard and realistic answers to these and other fundamental questions of procedure, priority, and responsibility.

Water pollution control is a national problem of the first magnitude, both in its relationship to water resources development and in its involvement with man's health. It is not, however, an insuperable problem. In a Nation such as ours, we can find enough money; we can develop enough scientific and technological capability, enough public concern, and enough mutual confidence and good will to reach a balanced solution.

The need is apparent. The problem will permit no further delay. It is my firm conviction that clean waters are indispensable to the future to which we aspire. It is my hope that all of us, and the organizations we represent, will dedicate our capabilities and resources unstintingly to the successful fulfillment of the plans and programs which this Conference will shape for America's future.

[Editor's Note: After delivering his prepared address to the Conference, Dr. Burney introduced the Honorable Murray Snyder, Assistant Secretary of Defense, who presented the Defense Department's Meritorious Award to Mrs. E. Lee Ozbirn, President of the General Federation of Women's Clubs and a member of the Conference Steering Committee. The Federation of Women's Clubs was presented the award for its outstanding work in improving relations between the civilian community and military installations throughout the United States and overseas.]

# A Matter of Survival

ALBERT E. FORSTER
***President and Chairman of the Board***
***Hercules Powder Company, Wilmington, Delaware***

It is a privilege for me to be here today. The subject of this Conference brings to mind the eloquent preacher in a great riverport town who was so impressed with the many-sided importance of his local stream, "the road that moves", that he wound up a sermon by thanking the Almighty for directing all big rivers to run through the big cities. This good man had his priorities misplaced somewhat, but his heart was certainly in the right place. For he plainly comprehended the basic importance of a continuous supply of fresh water.

Dr. Burney has said that the objective of this National Conference on Water Pollution is to reach substantial agreement on a set of national goals to halt water pollution and to draft specific programs to achieve the goals.

Perhaps this objective will prove to be too ambitious to achieve within the three days of this conference. At any rate, we are here because we recognize that there is a problem, one that must be solved.

Speaking as a representative of industry, let me remind you that industry must have a satisfactory supply of water as a simple necessity for survival. Let me assure you that a great deal of thought and study has been made on this subject by industry and that some success has been achieved.

I think our dilemma is best expressed by the distinguished U.S. Senator Robert S. Kerr of Oklahoma, in his book, *Land, Wood, and Water*, and I quote:

"We can bequeath our children cities of iron and stone and aluminum but we had better be sure we give them the water to make them liveable."

We have to look carefully at what Senator Kerr says to fully realize the magnitude of his statement.

I think we must face up to the question, "Whose responsibility is it to solve the water pollution problem?"

I submit it's not the responsibility of any one single segment of our society. It is not the sole responsibility of government, either Federal, regional or State. It is not the sole responsibility of industry or of citizen groups operating independently here and there across the land.

The responsibility for solving the water-pollution problem belongs to each individual American, working in communion with his neighbors until it becomes one all-consuming national effort. Every American contributes to the problem simply through the fact of his existence, and because of his insistance on a high standard of living.

The seriousness of the water situation is the fault of no one group or organization, yet every one of us is responsible for depleted stocks and increased requirements. Trying to point the finger of blame may be easy and tempting but, is utterly of constructive criticism.

We cannot expect our great industrial empire to turn out approximately $500 billion of gross national product—from aspirin to zwieback—without use of water for processing and return of liquid wastes to these waters with somewhat less than pristine purity. Yet, this inevitable cycle gives us no excuse for asking, "Do we want jobs or clean waters?" We want—and can have—both.

How do we assure the water requirements for more and more aspirin, zwieback and the thousands of products in between to meet the coming population explosion—and the insatiable demands of our people for more of the good things of life?

Recently there was proposed a three-part water management program in the Pacific Northwest. This was an industry-oriented program, one which I wholeheartedly endorse because it takes into full account the equities of all water users. This program would perform the following three steps:

1. By areas, the present and future beneficial water uses of an area would be determined and enunciated. These uses most certainly would include the disposal of industrial wastes as a legitimate water use.

And at this point I would like to emphasize the word "area". Water problems differ sometimes radically from one area to another. The answer to a problem in Delaware might be totally inadequate in California. For that reason the first step toward any solution of water resources problems must begin within the area, whether it be a municipality, State, or geographic region.

2. Water quality criteria would be established to protect these uses—criteria which would allow maximum use and reuse of the waters.

3. A program of monitoring to maintain required standards would be established and carried out.

This proposed program springs from a self-centered motive—the motive to survive. It is proposed by industry which is facing tremendous problems of industrial waste disposal. It is carefully thought out and it preserves the equities of all concerned.

Let's analyze our three-part water management program, item by item:

1. Present and future beneficial water uses, determined and enunciated.

A simple-appearing statement, yet it opens a veritable Pandora's box of unsolved problems. For instance: The Public Health Service tells us that 70 percent of the water that falls on the U.S. is returned each day to the sky by evaporation and transpiration. Of the 30 percent remaining, only one-half or 600 billion gallons per day can be kept available for use in our lakes and streams. The Public Health Service predicts that by 1980, now only 19 years away, "our fresh water needs will be 600 billion gallons per day, equal to the daily supply." One very important word was omitted from this statement. That word is *available*. This prediction was made on the assumption that the present supply of fresh water *available* for our use is only that portion now available after run-off, evaporation, transpiration, and so on.

This statement by the Public Health Service ends with the following sentence: "It is generally agreed that from now on the Nation's water needs can best be served by controlling pollution to permit the repeated reuse of the same water as it flows from city to city and from industry to industry."

The U.S. Department of Commerce in "Water Use in the United States, 1900–1975" agrees with the Public Health Service on precipitation and availability figures, but has a difference of opinion as to recirculation and reuse:

"By recirculation and reuse total requirements for industrial water could be greatly reduced, but the total consumption would not be appreciably reduced, because about 80 percent of the total consumption is in irrigation."

We are apt to overlook the tremendous extent to which the reuse of available water now makes the same million gallons of water serve many masters. It is estimated that the present reuse of water by industry approaches 100 percent, and that this may be expected to rise to 400 percent in the future—that is one gallon of intake water would be used five times.

This is a technology we are going to hear a lot more about, and we are also going to have to learn a lot more about.

It is obvious to those of you here today that conservation of water by dams and reserve stocks along our great rivers will assist materially in the near future both for supply and pollution control. I think it is also obvious that the de-salting of sea water on a cost basis which we can bear will become a reality before too long. Neither of these factors, however, will obviate the present and future need to reuse the water we have many times over.

Now, just what is the over-all situation in pollution control, and how effectively is it being handled today? For this, I refer to a talk given by C. M. Everts, Director of the Division of Sanitation and Engineering of the Oregon State Board of Health, at the 1960 annual meeting of the Water Pollution Control Federation in Philadelphia. Mr. Everts said:

"Measured by the number of sewage and industrial waste treatment or disposal facilities placed in operation, as well as improvements in water quality, State and interstate agencies are making progress in the control of pollution. Significant reductions in pollutional loads have been made in almost every State."

This is a statement of fact by a responsible official who is vitally concerned with the problem of pollution control. It shows that progress is being made.

Let's move on to the second item of our three-step program:

2. Water quality criteria established to protect these uses.

Here again a simple-appearing sentence opens another Pandora's box of unsolved problems. Companies with plants in several States sometimes must comply with a wide range of control criteria. Some authorities prefer point of use control; others insist upon point of discharge control of specific compounds. Many examples could be cited. Let's examine just one.

For many years the U.S. Public Health Service standards for water quality have included the figure of 250 parts per million for chlorides. Some three years ago a review was made of the history of this long-established control criteria. Questionnaires were sent to a large number of industrial water users. The literature was studied for factual background as to the effects of chlorides on drinking water, corrosion patterns attributable to chlorides on processing equipment, and so on. Many opinions were offered, some of them completely in conflict with others. Practically no facts of significance were found. In desperation three of the top men of the Sanitary Engineering Center of the Public Health Service in Cincinnati were asked how and on what basis the 250 parts per million was established. They agreed there was no basis for this figure except long custom! I should point out that Water Quality Standards are now being reexamined.

And now for the last item of our three-part program.

3. A monitoring program to maintain required standards. For our present purpose it seems fair to interpret the term "monitoring" in its broad sense, to include the power to discipline and control.

A beginning has been made toward comprehensive sampling programs for some major watersheds and a few of the important tributary streams. Such efforts should be welcomed and should be extended throughout the country. Of grave concern to industry these days is the very practical problem of the *who* and *how* of control.

In recent years a new control device has been developed. This is the regional compact in which a number of states join hands for water pollution control. Only four years ago the Federal Government was given control responsibilities in the field of water pollution abatement for the first time. So here we in industry must take cognizance of three layers of control authority: the State, the region, and the Federal Government.

It is safe to say that, by and large, industry recognizes that each of these levels of government must accept its proper share of the responsibility for supply and control of the Nation's water resources. But *how* this control responsibility is delegated and *how* each governmental layer approaches its task is a matter of vital importance.

Insofar as pollution control is concerned we might give careful consideration to the Engineers Joint Council. In their "Principles of a Sound National Water Policy" this Council of our major engineering associations states:

"Pollution of water should be regulated at the lowest governmental, level adequate for the particular situation. Some will be wholly local, some at State level, and some at State compact level. Federal jurisdiction and participation should be limited to the administration of existing laws; to research, investigation, and guidance upon which sound State laws and local regulations may be based, with as much uniformity as is consistent under the variable conditions encountered."

At this point, I would like to submit for your consideration a program and philosophy I believe must be embraced in order for us to succeed as a Nation in solving our water resources problem.

My first and most important proposal is that water resources and pollution control be considered on a State level, with funds, manpower, and dedication as important as highways and schools.

In too many States, attention has been put to these problems only when everything else has been budgeted, if indeed any action at all has been taken. What's left over provides a pitiful amount of money to engage the services of too few professionals in this field. And the whole program, small as it is, is stripped of any authority to do anything because the States' lawmakers are so blind to the critical urgency of it.

In most all of our States, the greatest emphasis, attention, money, and public support is given to highways and schools. Certainly, better schools and highways are needed, and undoubtedly more money can be wisely spent on each of these items. But at the same time, we must allocate more to water resources if we insist upon continuously raising our standard of living.

Therefore, I say that each state should have the necessary facilities, empowered by the necessary laws, and staffed by the best engineers, so that the over-all problem is licked first on the state level and working closely together with other Sates or interstate agencies on a regional level. Guiding this development of State and regional control should and must be the Federal Government, acting very much as our research and development team in industry does.

From industrial experience I have certain ideas about organization and methods which have the objective of obtaining the best possible results at minimum costs. Thus it is that industry has found, certainly within my own company, that considerable decentralization of the responsibility for operations brings the maximum of success at a minimum of cost, while centralization of activities such as research and the "setting of policy" is the most effective method.

Again drawing on my experience in industry, I wonder if in coping with this national problem of water resources we can't achieve regulation which establishes the objective and holds individuals—municipalities, industries, or even a State—accountable, thus permitting the greatest opportunities for individual action.

State and interstate control agencies must be able to call upon the Federal Government for guidance and counsel. A duplication of research effort on the state level would be impossibly costly and futile of any great achievement, since there are not enough trained personnel to go around.

Furthermore, the science of sanitary engineering is finding it increasingly difficult using known methods to solve some of the problems now being faced. New ones are cropping up every year.

Therefore, my second proposal is that a vastly increased research effort be brought to bear immediately upon the water pollution problem under the guidance of the Public Health Service, utilizing to a far greater extent than is now done the research programs being carried out by industry and private foundations on this common problem.

Coordinate, I suggest, all of the existing extensive research done on water pollution, find in that manner where more is needed, and then organize all of this knowledge and talent so that it may be immediately available and usable to anyone.

What will it take to carry out this research program? Public Law 660 of 1956 now provides for a broader research program within the Public Health Service and for greater Federal cooperation on these areas through research grants, research fellowships, contract research and training. In addition, it provides for strengthening the broad research program within the Public Health Service.

This is now being utilized to the extent consistent with appropriations being made under the law by Congress. It is evident that these are insufficient. Therefore, increased funds should be made available by Congress so that these programs in research can be implemented at a greater rate.

My third proposal, I sincerely believe, holds the key to success or failure of our common effort. I said at the start of my talk that the problem of water management in the United States is the responsibility of every citizen. Until a majority of our citizens is convinced, first that a problem does exist, second that we have no choice but to find a solution—and soon—and third that they must assume their share of responsibility in the solution, we as a Nation will fall short of the solution required.

In simple words, I am suggesting that a well planned information and education program must be launched and carried through to success if we are to solve our water resources problem.

This program of information and education is another example of a job too big for any one of us alone. We must establish a common ground of attack, pool our resources, our available skills and funds and then move on all fronts at one time to convey in many forms, and using many media, the vital importance of water conservation.

Government on a Federal, State and municipal level, industry and the citizenry, must work out together the management and improvement of this resource in order that we may continue to live and grow and prosper.

The American Water Works Association, through its "Willing Water" program, has done much to educate the layman in water supply and treatment. A program of this nature could well be the nucleus of a broader, thorough, and long-range campaign for education and enlightenment of the public.

In the last few decades, I submit that industry for the most part has not only assumed its responsibility in the conservation and safekeeping of water supplies, but has done so at a faster rate than many municipalities so anxious and eager to have industry as a neighbor.

The chemical industry, which I represent, has been outstanding in its program of water pollution control. In the past year alone, more than a hundred million dollars has been spent by the chemical industry of the United States on water pollution control.

Some of it has been done by edict, and I will be the first to admit that there are now—and perhaps always will be—those members of the business community who require the harsh arm of the law to make them act as good citizens.

I am gratified that most of it has been done voluntarily. The recalcitrants, like the bad apples in any segment of our society, and each segment has them, should be treated as the exception to the rule and not be allowed to blemish the reputation of the majority.

On the other hand, to cite one good example, look at the Kanawha Valley where industry and the West Virginia Water Resources Commission have worked together in developing a plan for control on the river. This cooperation resulted in the following program:

1. A joint five-man industry advisory committee has been established which meets regularly with the Commission.

2. Development of a revised method of plants reporting to the Commission.

3. Cooperative development of a new and streamlined permit system.

4. Joint development of data which has allowed the Commission to promulgate a definite plan of apportioning the assimilative capacity of the river.

5. Development of a set of curves on the river based on actual data collected which will allow real control by the Commission.

Certainly this is a real achievement.

I would like to take from my own community of Delaware, which is the headquarters of my company, another case history to show a pattern of success that can be recommended.

The mighty Delaware River, one of the first to be explored and settled in the earliest days of our Nation, supplies the needs of several major cities and a large segment of the eastern industrial community. Into it feed a number of lesser rivers which in the course of history contributed largely to the pollution of the Delaware.

The problems of pollution control and proper management and development of the Delaware River resulted in the setting up of the Interstate Commission on the Delaware River, known as InCoDel, in 1939.

This was a compact between the states of New York, New Jersey, Pennsylvania, and Delaware. By this compact, the signatory States have pledged to attempt to correct pollution and prevent future pollution of the interstate waters of the Delaware. This compact has now been in operation for about 21 years.

Let us look at the situation today, and for this I refer to the Annual Report of InCoDel given at their business meeting held in October, 1960.

First, InCoDel has maintained an up-to-date inventory of the various sources of pollution in the basin. This inventory shows that about 90 percent of the urban communities served by public sewers have installed sewage treatment facilities. Similar progress has been made in regard to the installation of plants for treatment of industrial wastes.

InCoDel has worked with Corps of Engineers and the Delaware River Basin Advisory Committee in the formulation of a comprehensive survey of the Delaware River Basin. From their report, they believe that the Army Engineers have developed a physical plan that will, when put into effect, substantially resolve many of the problems regarding control, development, and utilization of the water resources of the Delaware River Basin. Plans for 50 years ahead call for the construction of eleven major reservoirs costing 264 million dollars.

Here again an interstate agency has been of real assistance in helping to develop an over-all plan for utilization of a river basin, and in so doing has made effective use of the cooperation of all the various levels of government as well as industry.

In developing a total approach to adequate water supplies, we must consider maximum utilization of our flowing streams. No longer can we afford the economic loss from recurring periods of flood, or the waste of this water so necessary for implementing dry weather flows. Regulation of flow throughout the year will provide additional summertime volume, thus increasing the assimilative capacity of the stream as well as providing additional volume for use by all.

Such a program for harnessing our streams is one which must encompass an entire watershed and which would affect several States. It is therefore, one in which Federal participation must be considered. In such a national approach to our water resources problem, flood control, power generation (where feasible with flood control), flow regulation, and recreational use must be completely correlated for maximum use consistent with the economic benefits to be derived.

I would like to submit here that the problems awaiting solution are not just of a technical nature. There are also grave social and economic implications. Delegates to the annual meeting of the Water Pollution Control Federation held two months ago in Philadelphia were told by Robert G. Dunlop, president of the Sun Oil Company, that:

"While we seek to protect our valuable water resources, let us not wear blindfolds of cynicism. I would remind you that we have in America another precious heritage—the climate of individual freedom that has encouraged the development of initiative and resourcefulness. This is the key that has unlocked the door to our Nation's treasure chest of natural resources and made them available for the benefit of our citizens. So, in protecting one precious resource, we should be careful that we do not sacrifice another. We need to maintain a proper perspective, based upon the exercise of enlightened freedom of action. Panic will not help us find a panacea."

That is the end of Mr. Dunlop's statement of philosophy, and I don't think it can be better said.

To achieve our goals, I believe the following steps are necessary:

1. Full implementation of the state regulatory agencies in manpower and funds so that the over-all problems of supply and waste control are fully covered.

2. That an adequate program of research be provided, utilizing existing federal research facilities, outside research organizations, universities and others so equipped for special investigations.

3. A renewed realization that the administration of State and interstate pollution control programs must be basic and remain in the hands of these agencies.

4. Development of programs for maximum utilization of our rivers.

5. The need for a factual and informative program of public education on the absolute need for water management.

6. The Federal Government should be the organization for correlation of such a program.

When such an over-all program has been welded into shape and is operating fully, we will have taken the long step forward.

And such a step will mean survival!

# Pollution Is a People Problem

Dr. Ira N. Gabrielson

***President, Wildlife Management Institute***

Distinguished guests, ladies and gentlemen: It is a gratifying experience to take part in this National Conference on Water Pollution. The large attendance from all parts of the country demonstrates the intense concern about the vital water resources question that is before us.

Your presence gives credence to my observation that water pollution is essentially a problem of people. The Nation's waters are contaminated by people for the most part. People are faced with inconvenience and privation when effective pollution control is delayed. Their dollars pay for programs that are implemented.

I am hopeful that this assembly also is manifestation of a desire to make progress in abating water pollution. We all know that pollution's threat to individual and national well-being no longer can be tolerated. Pollution has outgrown social and cultural considerations; its impact now is economic as well.

The purpose of this meeting has aroused considerable speculation and interpretation. I personally prefer the view expressed by Secretary Arthur S. Flemming when he met with the Conference planning and advisory committee earlier this year. He said that he wanted this Conference to reach agreement both on national goals for water pollution control and on the kinds of programs needed to achieve those goals. The failure of this Conference to fulfill those objectives, the Secretary emphasized, would mean that it had been less than a worthwhile meeting. Secretary Flemming reiterated his position on November 17.

Many of you are engaged professionally with water supply, pollution control, and health activities of public and private groups. Others have close and continuous contact through association with water-orientated programs for allied municipal, industrial, agricultural, and recreational interests. You are acquainted with most facets of the pollution problem as it is known today. You are as familiar with the prevailing statistics of water supply, demand, and disposal as you are with the diverse philosophies that are brought to bear on programs advanced for remedial action. You also know that the locus of this problem is the plain fact that the demands for clean water exceed the supply in many areas.

Reports that analyze water supply and demand are in general agreement that little progress is being made in preventing the contamination of ground and surface waters. Case histories are cited for most parts of the country. Corrective action is not keeping pace with the problem. We are failing to improve and protect water supplies from the polluting effects of materials and conditions that we already have the technology to combat. Comparatively little is known about the new pollutants which are adding to the problem daily.

My purpose today is to identify the "public" that is affected by water pollution and to discuss opportunities for gaining pollution control objectives in light of present knowledge, experience, and probable trends. Helpful comments and viewpoints have been solicited from a number of national membership organizations and they are incorporated in this statement.

The public to which casual reference sometimes is made, and whose viewpoint I was asked to express today, consists of the 182 million people that inhabit this Nation. It is the sum total of all the people who use water. It extends from householders to farmers, from industrialists to recreationists, and from city planners to businessmen who try to accelerate community and State development and advancement.

Regardless of position and affluence we all share a common need for adequate supplies of uncontaminated water. We benefit from water that is clean, and we are penalized by that which is dirty. This is why I say that water pollution is a problem of the people.

Attempts to categorize beneficiaries of clean water in such general terms as fishermen, picnickers, and nature lovers is, to my mind, as erroneous as arguments that purport to show that certain interests would bear inordinate financial burdens should pollution abatement programs be accelerated to anywhere near the scale held necessary. The head of the family ends up paying the bill regardless of the pollution-control philosophy that is followed. He pays it in the form of extra cents on his shopping bills when the costs of industrial water treatment facilities are passed on to the consumer. He pays the costs as taxes which are levied to underwrite municipal, State, and Federal programs.

The people pay in another way when pollution abatement responsibilities are ignored. They pay by having to live with recurring water shortages, blighted neighborhoods, impaired health, loss of industrial, business, and real estate revenues, and sacrifice of social, cultural, and recreational opportunities. When waste treatment belatedly comes to those many areas where it has been delayed, the people still are going to be out-of-pocket.

Brief illustrations of how clean water can unite the extremes of recreation and industry are found in presentations delivered at the recent annual meeting of the Society of American Foresters. Director Dewitt Nelson of the California Department of Natural Resources noted that an intensive study in his State showed that fully 60 percent of all recreation is water-orientated. Californians put about 55.6 billion miles on their automobiles during 1960; about one-third of the total, 17.6 billion miles, was for social and recreation purposes.

The first question industrial representatives ask in Pennsylvania, said Maurice H. Goddard, secretary of the State's Department of Forests and Waters, is: "Can recreational needs of our employees be met close to home?" The industry looks elsewhere when these needs cannot be met, and an opportunity for community economic enhancement is lost. Have you noticed how often water recreation opportunities are held out both by advertisers of industrial acreage in Florida and by industries seeking employees to move there?

Some appraisals of the threat of water pollution overlook achievements that have been and are being made by industry, agriculture, and local, State, and Federal units. Progress has been made in a number of important ways. The industrial reuse of water appears to be increasing. Advanced processes are extracting noxious substances from effluents, and commercial uses are being found for these byproducts. Industrial plants are using sewage effluents in their cooling cycles. Basin-wide soil conservation programs reduce silt pollution, and some notable research, enforcement, and construction records have been acheived.

The record shows clearly, however, that these efforts collectively fall short of the mark. They are too few and too isolated to have substantial impact. Their over-all contribution to ridding the Nation's waters of wastes is comparable to an underpowered river boat on an upstream mission. The helmsman barely can succeed in keeping the craft headed into the current.

Much more must be done. Research must be accelerated and the findings applied. Industry should recognize pollution abatement as a regular operational expense. Clean water requires substantial expenditures at all levels.

A contributing factor to the present dilemma is the number of people who persist in viewing watercourses as sewage and waste disposal channels regardless of the difficulties imposed on others. Some polluters express reluctance to install costly facilities because available technology promises less than a complete reduction of the offensive wastes. They contend that little is gained by reducing the contaminant level by 80 percent if the remaining portion still renders the watercourse useless.

Fortunately, those points of view are being isolated by a countrywide tide of understanding and circumstances. The deterrent in 1960 to a forceful attack on water pollution is a clash of philosophies on how the mission should be accomplished. Few persons continue to question the national menace of water pollution. It is identified in the public mind as a serious and widespread threat.

The public now asks two questions. What programs are needed to combat this menace? When is a reasonable attack going to be launched?

Inspired, dedicated, and as well equipped as the staff personnel may be, State programs are hampered by the unwillingness, reluctance, or inability of the legislative bodies to provide necessary appropriations. Funds for State agencies have about tripled in the last decade, rising from $2.2 million in 1950 to $6.5 million last year. The average State and jurisdictional investment in 1959 was approximately $130,000, a grossly inadequate sum. This weakness is further underscored by the realization that 40 percent of the $6.5 million was invested by four States. Expenditures by the remaining States and jurisdictions averaged $80,000, which means that comparatively few dollars were available for active programs after salaries and other administrative expenses were met.

The Federal contribution to State programs last year was $2.6 million. Federal funds have comprised between 28.7 and 29.5 percent of the State's programs during the past three years. The record also shows that State investments fell off during the years 1953–56 when Federal assistance was not available.

You are acquainted with the Federal grants program for the construction of waste treatment facilities, I am sure. Its contribution to the over-all effort is well documented. You know that this program is stimulating nearly $5 in local expenditures for each $1 invested by the Federal Government. Grants to more than 2,000 communities have resulted in the construction of projects estimated to cost in excess of $1 billion.

Federal grants and assistance programs to the States are not recent innovations. The first began in the 1870's. Some have been questioned as to their national character, but most must be consistent with the desires of the people or else they could not persist.

It is my personal opinion, and one which apparently is held widely, that the Federal program of grants-in-assistance for the construction of pollution abatement facilities presently is one of the best approaches to this national dilemma that is making clean water a scarce resource. I say best for a number of reasons.

Foremost among these is the interstate character of much of our water and the dependency of all of us on that resource for individual and national well-being. Federal investment for the protection of our surface and ground water supplies is fully as vital to our national life as are expenditures for defense, post office, transportation, and agriculture, to name a few.

A second reason for my believing that clean water is a sound national investment is that no other effort in the history of this problem has made any significant progress in controlling this threat. The evidence of failure is all about us. It is as close to this hotel as nearby Rock Creek—a scant half-mile away—which is the nucleus for the Capital City's world famous park. "Polluted Water" signs confront the thousands of men, women, and children that take their recreation there each year. I hope you nonresidents can visit Rock Creek while you are here, and I suggest you follow the stream to the Potomac where, for the first time, recent developments hold hope for solid accomplishment.

Only three States have substantial grants programs for assisting municipalities in meeting their responsibilities for constructing water treatment facilities. They are Maine, Maryland, and Vermont. Several others—California, Indiana, New Hampshire, New York, Ohio, Oregon, and Pennsylvania—either have limited revolving loan funds, guarantee purchase of project bonds, provide assistance for plans, specifications and estimates, or contribute to project operation and maintenance expenses.

State leadership towards solving water pollution problems continues to lag. This failure was one of the motivations for enactment of Public Law 660. And the dim prospects for any greater participation appears to be the principal reason for the vigorous support of the Federal program by State water pollution control administrators and sanitary engineers.

Several points appear worthy of comment while reviewing past developments and anticipating what is ahead. Foremost among these is the conviction that water pollution control has outgrown its classification as primarily a public health problem. This is due in part to the efficiency of medical science in freeing Americans from the threat of infection from water-borne vectors. This conviction has emerged as a result of the tremendous population expansion and the parallel increase in the demands for water. Complex social and economic conflicts have arisen. The threat to health remains, of course, and may increase unpredictably in magnitude at some future time.

Pollution now rates full membership in the vexing relationships that dominate the entire water resources field. Freeing water of contaminants and preventing the introduction of additional pollutants is an overriding water resources challenge of this century. This technological and construction gap cannot be denied parity with flood control, storage, navigation, and irrigation.

Considerable attention has been and is being given to the advisability of strengthening the Federal water pollution control program. This is viewed both as a means of establishing logical Federal responsibility in this field and as a stimulus for obtaining more State participation. The suggestions that are being advanced range from a relatively mild realignment of the present program within the framework of the Department of Health, Education, and Welfare to taking the program out of that agency completely.

Some believe that the program should stay in the HEW Department, but that it should be elevated from its subbasement status and staffed so that its perspective can respond to and reflect the national interest in water resources. There also is a widely held belief that the program presently is guided predominately by public health considerations. Advocates of the elevation-and-strengthening theory point out that the activity's communication with other agencies in the water resources field needs improvement.

There is concern about the "Final Report of the Study Group on Mission and Organization of the Public Health Service," dated June 7, 1960, which recommends inclusion of the water pollution control functions in a Division of Water Supply and Pollution in a new Bureau of Environmental Health. Five of the six divisions of this bureau would incorporate functions and responsibilities of existing organizational units. This plan offers no boost for water pollution control. That activity already has divisional status. Other activities, such as air pollution and occupational health, which presently have only branch and program status, would be elevated to divisions. This recommendation clearly falls short of public expectations. Pollution control would remain a subbasement activity with a mission that is primarily directed toward public health. The published public record makes doubtful congressional acceptance of this report.

The subject certainly will receive attention during the 87th Congress. Water pollution control has been one of the most vigorously debated natural resource subjects to come before the Congress in years. The hearings, debates, record votes, and number of proposals reflect mounting public awareness and concern about this important subject.

Water pollution was a campaign topic for politicians in many parts of the country. The number of candidates who took positive stands on this serious matter is at an alltime high.

Extensive amendments to the Federal Water Pollution Control Act are being readied for introduction in the 87th Congress. These proposals most likely will include the status of the program within the Federal establishment, construction grants to municipalities, program grants to States and interstate agencies, extension and strengthening of Federal enforcement, and the control of pollution from Federal installations.

In concluding my remarks I want to comment on several points whose acceptance by all water users would do much to assist in achieving pollution control objectives. They are:

1. A national system of water quality standards from a health, recreational, industrial, and aquatic life basis should be developed and accepted by all units of government. These standards should be enforced vigorously and uniformly. Damage and loss should not be required as proof of pollution.

2. All users of water have the responsibility of returning water with all wastes removed from it that can be achieved up to and including ultra-cleansing where required. The national objective should be to keep pollutants out of streams. The design capacity of treatment systems should be computed for maximum treatment of wastes independent of the estimated capacity of streams to absorb and stabilize wastes.

3. Users of water do not have an inherent right to pollute. A desire for clean water was the foremost viewpoint expressed in communications from national membership organizations.

4. Public awareness programs should be expanded at all levels.

5. The public should insist that all jurisdictions accept and fulfill responsibilities to protect the national well-being by keeping surface and ground waters free of pollutants.

6. Pollution control objectives should be achieved by use of construction grants for waste treatment facilities, tax amortization incentives, watershed erosion control measures, and strengthened law enforcement at local, State, and Federal levels.

7. States and municipalities should be encouraged to participate more fully in water pollution control activities. Federal persuasion and leadership should be provided to obtain acceptance of local and State roles where necessary. The Federal Government does have responsibility for research, enforcement, grants assistance, and other necessary activities.

8. Federal assistance should be conditioned on guarantees of stronger State programs and improved participation in pollution control activities.

# The Water Pollution Image

M. D. Hollis

***Assistant Surgeon General, Chief Engineer, Public Health Service***

If there is general agreement that water pollution results from concentrations of people in a progressive dynamic economy, then certainly it should surprise no one that today this is an involved and complex problem. This is simply in keeping with the tenor of the times. A requisite need, perhaps, is to break down barriers of provincialism, the prejudices of proprietary interests, and varieties of narrow traditional points of view, too commonly shared by so many.

Representative at this assemblage, for instance, is an amalgamation of water pollution interests. This certainly is proper and is indeed as it should be. Some of these interests have long been known to coexist with something less than brotherly love. Interwoven in this problem are sources of friction—ingredients for dissatisfactions. But as citizens all, there is reason to believe that among this group there is something approaching a common denominator of basic concerns and aspirations, even though at times it seems a bit remote.

What is now important is to see if this national conference can stimulate something beyond a cool air of coexistence; to see if there can be a modification of the spirit of competing interest, of conflicting interest—to something more akin to a spirit of allied interest, of common goals, and common objectives. This is needed to remove the feeling of incompatibility between the reasonable protection of the Nation's waters and the obvious necessary use of these same waters for the final disposal of liquid wastes.

If such differences can be resolved, the result should contribute significantly to a long overdue, much needed, clear "mission for the Sixties." Certainly such an objective is important, and it is timely on this eve of a new year and on this eve of a new decade.

## The Problem

The first consideration is to ask why there is a pollution problem. For simplicity, this is discussed on a national composite basis. A reminder is that for any given watershed and for the Nation as a whole, average surface water supplies are constant. So much water falls on the earth. Here it divides among ground storage, evaporation, transpiration, runoff to streams, and finally discharges to the oceans. Land use practices alter runoff patterns. Impoundments modify rates of downstream flow. In the water cycle, these are significant influences, but they do not change over-all quantities.

The situation in 1900 is first considered. Urban population was 30 million. The population using surface water supplies was two million. Treatment provided was settling and filtration. Sewered population was 25 million, but there was practically no treatment. Wildlife and recreational values were relatively unimpaired.

By 1920, urban population had increased to 54 million, and those using surface water supplies, to 20 million. Coagulation and chlorination were added to water treatment practice. The sewered population increased to 50 million, 10 million of which were provided some crude treatment. Rumblings were heard about localized pollutional nuisances—about wildlife and recreational impairments.

By 1940, the urban population was 80 million. At that time 40 million people used surface streams for drinking water. Water treatment was improved. The sewered population was 70 million with about half providing sewage treatment. Secondary treatment became more common. Chlorination of sewage effluents was added in some cases. However, the total stream flow remains essentially constant. Localized pollution was more pronounced and extended. Resort areas were affected. Progressive deterioration of streams became a recognizable factor, public indignation increased.

A pause at 1940 is in order. What is this pollution from city sewers and from industrial operations, and what are its impacts?

1. Biological contaminants. These are living organisms, germs of all types, including those with the deadly potential of causing outbreaks and epidemics of human diseases. This is a continuing public health concern. The source is mainly household waste; more specifically, human sewage. With dilution and time, harmful germs ultimately die off in the stream. Chlorination of sewage effluents reduces the numbers of living organisms.

2. Organic contaminants. These are composed of unstable material that utilizes dissolved oxygen in the stream in the natural process of stabilization. The dissolved oxygen supports the type of bacteria needed to consume the organic matter. Thus, streams have the ability to cleanse themselves of organic pollution, if such loadings are not too heavy. Below points of such pollution the oxygen in the stream is used up, generally much faster than it is replaced. Within limits, and with time, the stream recovers from the shock of such pollution. On the other hand, if overloaded, the dissolved oxygen in

the stream is depleted; fish die, the aquatic balance is upset, and the stream becomes literally a sewer and a cesspool. In a sense, it becomes useless water. The source of organic pollution is largely cities and industries.

3. Inorganic pollution. These are acids, alkalies, and salts from mining operations, oil fields, metal plating, and a host of other industrial and commercial pursuits. Such pollution is persistent, and where excessive, degrades stream usage. Dilution modified the effects.

As to 1960, World War II gave great impetus to metropolitan and industrial growth. Urban population is now 126 million—up 55 percent over 1940. The population depending on surface streams for drinking water is 100 million—up 150 percent over 1940. The sewered population is 105 million, with 80 million subject to varying degrees of waste treatment.

### Effects of the War

Prior to 1940, there was a somewhat orderly transition from a rural to an industrial economy. Cities were still separate entities, generally with appreciable distances between shocks of pollution. Industries were in or near cities. Pollution, for the most part, was natural organic materials with concentrations of biological contaminants. Improvements in water treatment and extension of waste treatment kept the scales reasonably in balance. Excessive pollution, where it occurred, was still largely localized and over short stretches of streams.

Since 1940, three major influences aggravate the pollution situation. All three are World War II related:

1. There was a fantastically increased tempo in the transition to metropolitan and industrial development—the formation of gigantic metropolitan complexes extending hundreds of miles generally following major watercourses. Industries go where there is water and populations build up where there is industry.

2. There was practically no construction of municipal or industrial waste treatment works over the period 1940 to 1947. Men and materials were needed for the war effort.

3. The avalanche of technological progress brought with it a whole array of new-type contaminants, such as synthetic chemicals and radioactive wastes. Production and use of such materials continue upward at substantial rates.

### Future Trends

By 1980 the urban population will be in the 200-million range. The population depending on surface streams for drinking water will be about 165 million. The sewered population will be at 200 million. It is assumed that all waste will be treated. Average stream flows will be the same. For most streams the waves of pollution shocks will become somewhat additive; there will be little time for the stream to recover between such shocks. Distances between waste outfalls and water intakes will be wedged closer and closer together. Hundreds of new type, more persistent pollutants will further complicate the situation.

The pollution image will broaden and likely it will darken. At the same time, water needs will spiral upward toward astronomical figures. Repeated reuse of waters will become the rule, not the exception. Three-fourths of the 1980 population will live in metropolitan areas. Six-time reuse of the same water must be anticipated. What then will water quality be like? What will the stream environment be like? What about recreational and aquatic values? These are pertinent questions.

This representation of composite stream and urban development obviously is an oversimplification. For one thing, it does not include the industrial waste picture. Accurate data simply are not available, but industrial growth since 1940 has been much more phenomenal even than metropolitan growth. Further, there are wide variations between streams as to the type and extent of pollution as well as stream usage and needs.

In the past there has been heavy dependence on dilution water—"solution by dilution." What about supplementing streamflows? There is general agreement that, as a continental unit, the Nation actually has enough water. The problem is one of poor distribution, both geographically and seasonally. Within a given watershed, impoundments can do much to even out floodflows, but there are practical limits.

How feasible is it to redistribute water between watersheds? The more realistic method is the laborious one of transporting water on the ground. On this, intriguing possibilities come to mind. Envision an interlacing interbasin network of canals and conduits fed by surplus floodwaters from major rivers and, even more enticing, fed by waters from the Great Lakes. In terms of engineering feasibility, cheap power would be the key.

But before becoming too ecstatic in flights of fancy, practical, legal, and political realities must be reckoned with. Diversions of waters from natural watersheds introduce fundamental questions of economics, basic water law, water doctrines, and ownership of water. Already, there are innumerable examples of these conflicts where such diversion is practiced or proposed.

The conversion of sea water has intrigued scientists over the ages. While striking progress is being made, the practical economics of desalting and the major logistics of transportation, place this means of augmentation at some distant future and with limited application.

This is certainly true in terms of inland areas and general water needs, such as more water for dilution of waste.

The science of weather modification, to supplement rainfall by artificial means, has been suggested. Without debating the pros and cons, the practical application of this science as a substantial adjuster is a long way off.

Accordingly, for the predictable future, reality seems to dictate, for the most part, the necessity for using what is now at hand, basin by basin; that completion of the network of impoundments to even out floodflows be accomplished; that work be done toward the more equitable use of water; and finally, that the most reasonable method of "providing" more water is to "save" more water. And the best way to save water is to avoid excessive pollution of streams. There is always a return to the basic necessity of effective treatment of sewage and waste as a practical means to reduce pollution, and to preserve water quality for repeated reuse as streams flow from headwaters to the oceans.

## Actual Status Today

Now, what is the status today? A hundred million people depend on surface streams for drinking water; 105 million are connected to sewers discharging essentially to these same streams; industrial growth is accelerating; aquatic recreation is in higher demand.

Remember that waste treatment is partial treatment—not purification. Treatment is designed to condition the waste, and reduce its pollutional shock, with the stream completing the job. For most areas, this concept is still workable and will so remain for the predictable future. Economically this is important, because costs are quite high for advanced stages of treatment. On the other hand, in some areas, the composite residual loadings after treatment are already overtaxing stream capabilities. This situation will become common in the years ahead. Improved treatment will be needed. This is one of the several new situations that must be faced as progress is made toward the bright new world.

## Public Health Aspects

Now, what about the public health implications of the changing pollution picture? In man's contemporary environment, contaminants in air, water, and food are becoming somewhat interrelated in their impact on health. Earlier in the century public health practice focused on the microbiological factors causing diseases in man. With respect to water supply and sewage disposal, attention was directed, and properly so, to the problem of controlling germ diseases, largely enteric infections. This effort has been brilliantly successful—waterborne epidemics and outbreaks have been virtually eliminated. Communicable diseases continue to be a plague; problems will be aggravated with population concentrations. The safety factor grows correspondingly thinner. But it should not be too difficult to strengthen the protective barriers. Deficiencies in handling biological contaminants will be due largely to shortage of vision and to apathy, not to lack of scientific know-how with time-tested practical application. The problem of viruses does represent an exception.

The postwar focus of public health has broadened to include major attention to the chronic impairments of man—to changing environmental stresses. Fair has stated, ". . . there is a significant difference between the environmental stresses of the nineteenth century and those of today; those of a century ago were allied principally to microbiological factors; those of today have their source in microchemical substances."

### New Contaminants

Today metropolitan and industrial wastes are huge in volume and include increasing amounts of new-type synthetic chemical contaminants. Most of these wastes were practically nonexistent in 1940. Now they are present in concentrations up to 0.5 mg/l in several major streams. These synthetic organics do not break down like natural organics, are persistent over long periods, and, to a large extent, are not removed either by sewage treatment or by normal water purification practices. There is much to learn about the behavior of these new contaminants in streams; their relationship to natural stream purification phenomena; and their long-range subtle effects on public health, on aquatic life, and on municipal and industrial water supplies. They add the question of toxicity to the age-old problems of typhoid fever and similar diseases.

The buildup of these complex conglomerates in streams and even their low-level existence in drinking water in itself is no basis for alarm. But certainly it must be learned what these materials are and how to measure them. More must be learned about the long-range chronic effects, about combinations, and about synergistic potentials. Radioactive waste is another contaminant introducing new problems, new dimensions, and new headaches.

This aspect of the pollution situation is characterized more by what is not known than by what is known. This is not the type of problem that should be "swept under the rug" and forgotten. It needs to be in the open and it needs to be worked on. For when trends are projected for a decade or two, this aspect of pollution does have sobering implications and creates a real sense of urgency for research action now. The public health aspect of water pollution again moves front and center.

### Contaminants from Runoff

In a word, sewered waste today is a vastly complicated material, compared to what it was before 1940. This points up the second of the new situations. Another contributing factor, as yet undiagnosed, is the impact on stream usage of nonsewered contaminants; for example, the residue from some 500 million pounds of synthetic pesticides produced annually for agricultural practice.

This is an era of accelerating change, with increasing tempos affecting almost every facet of daily living. Pollution control in the past has been largely corrective. In the future it must be preventive. Remedial measures must replace corrective actions. The tenor of the times and the complexity of the problem simply outmode the philosophy of postponement. The present so soon becomes the past that continually, from here on, work must be done with a critical eye to the future.

When 1980 or 1990 is considered, no longer is it some dim future that the next generation might worry about. On water pollution the need for clear concepts and principles, for stepped-up research and bold action cannot be postponed. This need is not tomorrow—it is today. Perhaps even it was yesterday.

### Recreation and Aquatic Life

With respect to recreation and aquatic life, pollution has progressively degraded these values in most areas of the Nation. Degradation runs the gamut, ranging from impairment of natural values, to destruction of fishfood chains, to periodic fish kills, and to extinction of beneficial aquatic life. By way of exception, there are excellent examples, such as the Schuylkill River in Pennsylvania, where degradation has been reversed and a desirable natural balance restored. The favorable economics of this action is a matter of record.

There is certainly little doubt of increasing public demand for preservation and recreational use of water resources. One need only review the statistics on boating equipment, aquatic sports, fishing, and hunting paraphernalia to be convinced, both of public attitude and measurable economic potentials.

But now a caution—it must be remembered that increased leisure time and high standard of living, which enable Americans to enjoy these recreational pursuits, have their roots deep in the industrial-technological economy. The byproduct liquid wastes from man and machines and runoff drainage ultimately must be discharged to streams. Accommodation of this reality in many congested areas will limit the practical extent that all natural values can be preserved.

It must be recognized that to enjoy the great advantages of modern technology there must be acceptance of some of the consequences. Pollution is one of these. But the pollution impact from human activity in these areas of "wall-to-wall" people can be moderated—and it must be moderated. How clean and pure the attempt is made to maintain streams is a matter of economics and realities, and of values both tangible and intangible. If the objective is pristine purity for purity sake, it is easy to "price" the public out of progress. On the other hand, if the objective is solely the dollar sign, continually to undercut the necessary cost of controls, it is easy to "prosper" the public out of critically essential water resources. Between these extremes come the tough hard choices.

## How Far?

To say it costs too much to prevent excessive pollution is just plain nonsense. But there is needed a clear understanding and a clear definition of "excessive." Obviously, pollution must be kept below the levels of significant personal health damage. It should be kept within bounds that do not destroy recreational and wildlife values. It is desirable to keep pollution within bounds which preserve the natural stream habitat. For every stream, each of these levels has its corresponding price tag—and it is sure that the cleaner and purer, the higher the cost. And present cost will move upward where there are ill-advised, indiscriminate watershed developments.

In other words, while there are limits to what can be accepted as technological progress, there are also limits to how far such progress must, or will, yield to desirable but less than critical aspirations. The difficulty always lies in identifying limits. Certainly these cannot be generalized; necessarily they will vary, from area to area, and from stream to stream, depending on the state of development and other realities. This emphasizes the need for development of truly comprehensive water use programs—basin by basin—with some means of assuring strict adherence to the agreed-upon plans and objectives. With a few exceptions, this is not now in existence.

## Need for Reality

Water pollution is an involved, complex, economic, technical, and political issue. It must be dealt with in terms of realities of the times. Metropolitan growth and technological advances are predominant influences. Volumes of waste spiral upward—the composite types and character of wastes are becoming more complex and more difficult to handle. Water needs and stream usage are increasing at unprecedented rates. Average stream flows remain essentially constant. This is a vicious cycle—more men and machines demanding more water to produce more pollution to degrade these same waters. Specific remedial actions should be based on specific cases. Simple generalizations are to be avoided, except as a reflection of the pollution image. Otherwise there are warped answers, unbalanced equations, and a great deal of frustration.

For example, if runoff waters were uniformly spread throughout the streams of the Nation and if polluting wastes were similarly apportioned, there would be no major pollution problem and no major water use problem. But this is not the situation.

Today, while water pollution varies widely in different areas, it is being held generally within livable limits. But there is a tough job ahead—and a continuing one. The annual rate of constructing municipal sewage treatment works has now about doubled over the 1950 to 1955 average. Much of this construction has been in congested areas such as the Ohio Valley, the Delaware Valley, and coastal tributaries. There are innumerable examples where sewage treatment works of recent vintage have improved the oxygen conditions below metropolitan centers and where bacterial pollution (as measured by *B. coli*) has been notably reduced. This is real progress—it literally has averted cesspool conditions in these areas. Industries, too, have done a great deal in an effort to keep up with the fantastic growth rate of production. But even as these actions are taken, the growth pattern continues.

## Present and Future Needs

In these times it is necessary to run faster and faster to stay in the same place. Annual construction should be $600 million—up 50 percent over the current rate—to take care of the backlog, the increasing sewered population, and obsolescence. The latter will increase substantially in the Sixties. Assuming the industrial waste load as equal that of municipalities—and certainly it is no less—this means a construction rate of more than a billion dollars per year on into the future. There is no substitute—it must be faced.

Actually, is this situation substantially different from the growing needs for highways, for schools, for hospitals, and other public works? Isn't this the price range that should be expected in this accelerating technological society? Should not the public be willing to bear the reasonable cost of municipal and industrial waste treatment, through some suitable mechanisms, as the price to preserve streams?

In many areas, the question of "willingness" becomes somewhat academic. More treatment will be essential to protect drinking water and to preserve some semblance of wildlife and recreational values. For decades far too little of the public works dollar has been apportioned for sewage treatment. There has been much argument about the pollution image, but much less done to balance the scales.

Again, it must be kept in mind that present construction provides for partial treatment, a sort of "cosmetic" treatment to eliminate unsightliness—to reduce the more acute effect of pollution shock below points of discharge. By way of example, compare municipal pollutional discharges of 1960 with 1940. Sewered population is up 50 percent in 1960 over 1940 (from 70 to 105 million). At present, 25 million discharge sewage with no treatment, compared with 30 million in 1940. A composite of the Nation's sewage treatment plants (in 1940 and 1960) reduces organic pollution by about 50 percent. Accordingly, in 1960 there is 30 percent more organic pollution load on waters than in 1940. Projecting this simple arithmetic to 1980, at present trends, the organic pollution load will be up another 55 percent over 1960, or 100 percent over 1940. Remember that this is just municipal waste, does not include industrial waste, nor do they include synthetics or radioactive waste. This example is cited to emphasize that this discussion is not about eradicating pollution; it is about confining it—limiting its impact on legitimate stream usage.

### Summary

In summary, at least five factors need to be underscored:

1. There is less and less justification for any city or industry to discharge untreated sewage and waste to the waters of the United States, especially the inland waters.

2. For most cities and industries, the treatment requirements will shade upward from primary treatment (35 to 50 percent reduction in organic pollution) to at least secondary treatment (75 to 90 percent reduction in organic pollution). Chlorination to reduce bacterial pollution will become the rule in many areas.

3. It is important to accelerate promptly the rate of constructing treatment works to the level required to erase backlog and to keep up with growing needs and obsolescence.

4. A substantial program of research with three primary objectives is needed;

(a) To assess the public health significance of the growing array of new-type contaminants;

(b) To develop practical methods for measuring and removing dissolved pollutants—for application where wastes have serious toxic potentials;

(c) To develop practical supplemental treatment methods to stabilize further the effluents from conventional treatment. This is for application in those areas where stream use justifies almost completely stabilized organic discharges.

5. Considering pollution from all sources, there is real need to update the national system of monitoring streams. Actually, this is the only practical way to maintain a check on existing conditions and trends in stream quality.

In these five items there is nothing inconsistent with formal positions taken by numerous national groups interested in water pollution. Further, as to immediate treatment needs for specific cities and industries, for the most part these have been set forth by responsible State and interstate water pollution control agencies.

The real problem is to gear-up implementing actions in phase with the swift moving trends of the times. A great deal is now being done, but certainly not enough. Financing obviously is the key, to provide resources for intelligent action by official agencies and to provide for constructing waste treatment works. The difficulty is to "catch up" with treatment needs; after that, to "keep up" should be less involved.

In water pollution all have much in common and much at stake. Water pollution control is now big business—it's important business and it's urgent business. On a tonnage basis, waste treatment is, by far, the biggest business in the United States. In far too many areas it has been a neglected business. The only way to control pollution is to treat wastes, and this costs money—lots of money. With few exceptions, this money is not willingly spent. Hence, public understanding is essential and this must be backed up by effective regulatory controls. Just where the authorities are placed, the extent, and how they are applied, raise basic questions of public policy. Methods of financing essential treatment works, of supporting necessary research and development, are also public policy issues.

Again, this points up the great need for public understanding and public awareness. This is a challenge and an opportunity to speak out on the pollution situation. The objective should be to alert, not alarm—to clarify, not confuse. As progress is made, Mr. Citizen should be kept in mind, because so much depends on what he thinks, and wants, and is willing to pay for.

## Banquet

*Monday, December 12*

*Presiding,* DR. LEROY E. BURNEY
***Surgeon General***
*Master of Ceremonies,* JOHN CHARLES DALY
***Member, Water Pollution Control Advisory Board***

# The Legislator Looks at Water Resources and Water Pollution Control

**Senator Robert S. Kerr, of Oklahoma, Chairman of the Senate Select Committee on National Water Resources**

[Excerpts]

We must no longer endanger the national health or survival by permitting a price tag to prevent action. We must do what is required. I believe this will be the attitude of the new Congress and the new Administration.

The time for just talk has long since passed, and I am sure that everybody here is fully aware of that. Vigorous action at every level of government has long been an urgent necessity, and becomes more so daily. But, for whatever reason this Conference was called, it can, and will, accomplish something real, by spurring the necessary action. We in Congress need your support to get this job done. Why isn't this the time and place to start an organized campaign?

On the opening day of the 87th Congress I will introduce another pollution bill with the added feature of a stepped-up program of research.

Thus far, research has been so inadequate that the question of pollution elements, not yet identified, may be as serious as the problem of neutralizing and handling the pollution already known to exist. Therefore, greater research is an absolute necessity, not as a vehicle for passing the buck, or as a justification for delay. It is a necessity as a means to find ways to better abate pollution, and to do it more rapidly at less cost.

I quote "conservative sanitary authorities" who say that $600 million annually for the next 8 years is the minimum required for the construction of disposal facilities of human sewage alone. Added to this is the cost of handling industrial and natural pollution, plus the maintenance of a steady flow of water for waste dilution.

[EDITOR'S NOTE.—Senator Kerr has introduced the new legislation which includes an increase from $50 million to $75 million annually for the Federal matching funds to help construct municipal sewage disposal plants. The ten-year total authorization would be $750 million.]

The problem of water pollution, like that of municipal water, is primarily a local responsibility. Both Federal and State governments must provide leadership and assistance. At the Federal level, I intend to do all I can to help pass the necessary legislation to provide both incentive and enforcement.

[EDITOR'S NOTE.—Senator Kerr, pointing out the need to dramatize the menace of water pollution, suggested facetiously a "mermaid with a broom" as a popular symbol necessary to awaken the Nation to the need to clean up its streams. Such a symbol, he said, would do what Smokey Bear and the Litterbug label have done to alert the public to the need to combat forest fires and to prevent littering of streets and highways.]

## Senator Francis Case, of South Dakota, Ranking Minority Member of the Senate Public Works Committee

[Excerpts]

In addition to the millions of cubic miles of ocean water, how much more salt and otherwise minerally polluted water exists in underground pools and streams, I lack the imagination to estimate. But our knowledge of artesian supplies and shallow wells that are heavily saline in character indicates that a tremendous reserve does exist when man achieves the conquest of desalination and demineralization.

We are at work on this job. In 1952 Congress passed a bill which authorized a program of research contracts with private and public institutions in the desalination of water. It attracted little general attention at the time. We had difficulty getting appropriations. I recall once, when a Boston scientist was being badgered by questions as to what he would do with the money, he asked: "If I knew what we would find out," he replied, "we wouldn't need the research."

But we did get some funds and in 1953 research contracts were made with some of the organizations or institutions which had shown some interest in the field.

First thoughts were of sea water because of its abundance. California Congressmen Fletcher, McDonough, Phillips, and Engle, the latter now Senator, had all pushed bills on the subject in the House. Senators Anderson of New Mexico, O'Mahoney of Wyoming, Cordon of Oregon, Hayden of Arizona, Wiley of Wisconsin, and Johnson of Texas, were among those most active in the Senate. My special interest stemmed from a fairly intimate acquaintance with alkali water and its brackish cousins in the arid and semiarid regions of the West.

The initial program was organized in the Interior Department by David Jenkins of Ohio. Subsequently, Secretary Seaton created a full-fledged Office of Saline Waters and placed former Nebraska Congressman Dr. A. L. Miller in charge. His professional knowledge and energetic direction have done much to bring the program to where it now is—one of the most promising and constructive activities of the Federal Government in the whole field of water conservation and utilization.

Research contracts on various processes have been carried on with both oceanic and inland waters. In 1955 we extended and expanded the original authorization. By 1957 a number of processes showed real promise. Senate committee hearings developed testimony which supported the belief that results warranted practical, full-size demonstration plants. In 1958 Congress passed, and President Eisenhower approved, a bill to authorize five practical-size demonstration plants—three to deal with sea water, two to treat inland brackish waters.

This program is now under way. The location and the processes of each one are revealing as to the nature of this water pollution problem and the range of solutions.

Plant No. 1 is now 40 percent complete at Freeport, Texas. It will convert 1,000,000 gallons per day of Gulf waters into potable drinking water at an estimated cost of 97 cents per thousand gallons. If increased to a 10 or 15 million gallon capacity, the cost can be cut in half, it is believed. This plant will use what is known as the long-tube vertical distillation process.

Plant No. 2 will be at Point Loma, San Diego, California. Groundbreaking ceremonies are being held December 19, 1960. It, too, will produce 1,000,000 gallons per day, using water from the Pacific Ocean in a multiple effect evaporation process.

Plant No. 3 will be at Webster, South Dakota. Contracts for it have recently been signed and construction will start in the spring. This plant, using electrodialysis with water passing thru membrane stacks, will treat waters that are about 2,200 parts per million in solids. Many towns of the West have a constant battle with such waters that eat out or clog water pipes and sewer lines with a variety of effects upon the human system. Its capacity will be 250,000 gallons per day and the cost is expected to be in the vicinity of 50 cents per 1,000 gallons.

Plant No. 4 will be at Roswell, New Mexico. There, water will be used that has a hardness of 24,000 parts per million. A process will be used of forced vapor circulation with drop condensation.

Plant No. 5 will be located somewhere on the East Coast of the United States to work on waters of the Atlantic Ocean. The process will probably be an adaptation of natural freezing similar to one that has received considerable publicity for use by the new State of Israel.

Dr. Miller envisions an eventual cost of water recovery by these methods approximating 30 to 35 cents per thousand gallons. This can be put along side of an average distribution cost for American cities of 35 cents as estimated by the American Waterworks Association.

The contaminated waters of the Potomac river flow into the Atlantic ocean. And even the longest of rivers winds at last into the sea. The very processes of distillation and recovery which are being developed in the saline water program may offer the answer to many local water pollution problems with which your conference will deal.

And may I remind you that the disposal of atomic wastes probably carries the ultimate threat in water pollution. Radioactive raindrops disturb not only water supplies but milk and growing crops. Even lead-lined boxes deposited at sea offer cause for concern—especially since bathysphere divers last summer discovered that fish living at the bottom of the ocean's deepest trench depend upon oxygen carried to them by deep-sea currents.

One of the staunchest supporters of the desalination program has been Senator Anderson, for many years chairman of the Joint Atomic Energy Commission. His interest springs, in part, from his belief that what is developed in this program may be important to man's survival in an atomic age.

This program of desalting or demineralizing the great ultimate reserves and storehouses of the world's water in the oceans and the underground reservoirs may seem so vast as to be discouraging, as are some of the profit-protecting practices employed by industry and the topsy-grown habits of modern life which pollute our streams. But progress is being made.

## Representative John A. Blatnik, of Minnesota, Chairman of the Rivers and Harbors Subcommittee of the House Public Works Committee

[Excerpts]

I plan to introduce extensive amendments to the Water Pollution Control Act when Congress convenes in January.

These proposed amendments will call for (a) greater Federal research, (b) expanded Federal enforcement jurisdiction, (c) stepped-up Federal aid to communities for the construction of waste-treatment plants, (d) extended Federal grants-in-aid for State pollution control activities, and (e) the establishment of an independent agency in the Department of Health, Education, and Welfare to handle Federal water pollution programs and activities.

The problem of water pollution has been too long ignored by all levels of government, by industry, and the public as well. Despite

12 years of Federal efforts, the pollution problem is worse than ever, costing the Nation over a billion dollars a year in lost resources.

Water pollution is no longer primarily a health problem. The control of pollution is a key aspect of the entire water resource problem. Effective pollution control is necessary to permit repeated reuse of water in the coming years when the demand for water will equal and exceed the available supply.

Industry opposition to Federal pollution control legislation is shortsighted in view of industry's great need for water. Industry should cease its opposition to Federal grants to municipalities, especially in view of industry's support of tax benefits for themselves for the construction of industrial treatment facilities.

### Representative William C. Cramer, of Florida, third ranking minority member of the Subcommittee on Rivers and Harbors of the House Public Works Committee

[Excerpts]

The Federal Water Pollution Control Act of 1956 is a "step in the right direction" but I plan to strengthen the Act by introducing amending legislation in the 87th Congress.

Amendments to the 1956 Act will have four principal objectives:

1. To strengthen State and interstate water pollution control programs.
2. To make more effective assistance to municipalities in the construction of necessary sewage treatment works.
3. To provide for more effective prevention and control of water pollution caused by Federal Government installations.
4. To strengthen the role of the Federal Government in abating pollution of interstate waters.

I intend to introduce legislation which would extend the provision for Federal grants to State and interstate water pollution control agencies for administration of their programs.

Legislation which, if passed, would make it possible for several communities to get individual Federal grants and use these funds in the construction of a single sewage treatment facility.

I would make all interstate navigable waters and coastal waters subject to Federal abatement enforcement authority whether or not there is a showing of interstate pollution if abatement action is requested by a State or municipality with the concurrence of the State, and I would also authorize the Secretary of Health, Education, and Welfare to issue final orders in enforcement actions.

Discharges from Federal installations should be subject to administrative findings and recommendations in Federal water pollution abatement actions conducted by the Department of Health, Education, and Welfare.

I believe that these proposed amendments will provide an improved statutory base for the Federal-State water pollution control and abatement program.

With the shift of people from farm to city as the mechanization of farm operations has reduced the need for farm labor, it is almost trite to point out that we have become an urban Nation. What is of greater significance is that we are rapidly becoming a metropolitan Nation. Between 1950 and 1960, over 85 percent of the net increases in population occurred in metropolitan areas, and it is estimated that by the end of the century, only about five percent, or perhaps 17 million people out of a total of around 330 million, will live on farms.

With the area from Washington-Norfolk to Boston, Massachusetts, becoming largely a metropolitan area, it is obvious that even metropolitan water problems have become interstate problems, as have many other natural resource problems. This fact has recently given rise to numerous requests by States for interstate compact ratification legislation by Congress. Such compacts obviously are essential and can serve useful purposes in many instances.

Constitutionally the Federal Government's authority has traditionally been mere ratification, thus permitting the States to act under such interstate compact authority. Recently legislation with the Northeast Compact Bills, as an example, proposed a drastic deviation from established policies by providing for actual voting participation on such compact commissions by the Federal Government representatives, including the right of veto. This involves a very serious State-Federal relationship as well as constitutional questions which resulted in the Justice Department's opposing this approach last session.

Concurrently, with this growth of the metropolis, a rapid increase in personal income and in general living standards has taken place which has provided people with both far greater leisure time and means with which to enjoy it. The resulting trek to sun, sand, and sea has resulted in a boom in my own home State of Florida which today is not only stimulating private enterprise to provide for all of these people who seek recreation and relaxation in a benevolent climate, but has induced efforts to develop new types of industry and commerce to provide economic opportunity on a year-round basis for our tremendous increase in population which this boom has brought about.

But these situations have brought about a most important bearing on our national water resources picture. Huge quantities of water of acceptable quality must, in the future, be provided for these areas. And of even greater significance, the waste products of these great congregations of people must be properly disposed of in such a way as not to foul our rivers, lakes and oceans, if they are to continue to supply not only water for municipal and industrial use, but for the support of fish and for the creation of environmental factors required if we are to enjoy our increasing leisure time.

# PANEL I

*Tuesday, December 13*

## Water Pollution and Our Changing Times

*Effects of Pollution on the National Health, Welfare, and Economy*

**Chairman**
Hon. THOMAS A. McCANN
*Mayor, Fort Worth, Texas*

**Co-Chairman**
DWIGHT F. METZLER
*Kansas State Board of Health*
*Chairman, Conference of State Sanitary Engineers*

**Public Health Service Resource Personnel**
J. H. SVORE
W. E. GILBERTSON
J. R. HARLAN
R. S. GREEN

## Morning Session

**Hon. Thomas A. McCann, *Presiding***

When I was asked and I accepted the role of chairman of this very important session of your Conference, I considered it a great honor both to me and the State of Texas.

Your panel will attempt to cover the subject of water pollution and our changing times and a discussion of the effects of pollution on the national health, welfare, and economy.

This is your Conference. This is your panel. We want you to take a part in order that it may be beneficial to us all.

For the past eight years, from my observation and study as mayor of the city of Fort Worth, as a member of the executive board of the United States Conference of Mayors, and as a member of the American Municipal Association, I have been keenly aware of the critical situation confronting the country in providing an adequate supply of water.

After becoming a member of the Water Pollution Advisory Board, my concern has greatly increased.

I am convinced that the proper development of water resources and the ultimate availability of an adequate supply of good water will determine the destiny of our Nation and the ultimate survival of our people.

It is estimated that the Federal Government has spent $20 billion on water projects, that some $6 billion in water projects are now before the Congress awaiting authorization, and another $6 billion in projects has been authorized but no funds have been appropriated.

I know of my own knowledge States and hundreds of municipalities have expended enormous amounts of money for construction of both public and private water plants and other facilities in the past six or seven years. In spite of this effort at the Federal and State level and the municipalities, and including other public and private agencies, we do not have sufficient water projects to provide the amount of water of acceptable quality that we will require by 1975.

Therefore, unless something is done and done quickly, the disturbing fact is that the United States will face a severe water crisis.

Water resources planning must be conducted on a regional or interstate basis with each of the major river basins as a comprehensive unit. Rainfall evaporation and transpiration continue in an unbroken cycle as water works its way slowly to the sea. The constant movement of surface and ground water disregards city limits and State boundaries. Economic, political, and legal factors make it impossible for a State or a municipality to develop a river basin resource program without the cooperation and participation at all levels of government.

No single aspect of our water resources program can be solved alone. Progress will be made only through the cooperation of the municipal, State, and Federal Governments.

Now, gentlemen, this is the working part of this Conference.

We're going to ask for agreement and disagreement about what is said here today. Decorum will be the order. And we certainly hope we have no discord.

# Assessing the Water Pollution Problem

DWIGHT F. METZLER

***Director, Division of Sanitation, Kansas State Board of Health***
***Chairman, Conference of State Sanitary Engineers***

Only historians will be able to tell whether the accurate evaluation of the water-pollution problem in the decade of the 1960's was more important to this country than putting a man in space, but I believe that it is. A good case can be made for assessing the water pollution problem, for such an evaluation is necessary if the United States is to live within its water budget. We must not spend more than we have by unnecessarily wasting this resource through careless discharges from our soil, our industries, and our cities. To know whether we are living within our budget, and to make corrections where we are not, we must have an accurate assessment of the water pollution problem. This offers the fastest way to increase the net available water supply.

Solving some water pollution problems made 2,100 miles of U.S. streams available for use during 1956–59 and benefited 21 million people. Even with these improvements the waters of the Missouri River are being defiled by raw sewage from Sioux City, St. Joseph, Kansas City, and St. Louis; the mighty Mississippi is degraded beyond tolerance near its mouth; even with modern sewage treatment, Chicago must fight for increased diversions from Lake Michigan to keep the Illinois River usable; pollution of the Potomac is a national disgrace, and miles of ocean beaches are closed to recreation because of pollution.

The growth in population is contributing to the pollution problem and to the necessity for waters to be cleaned and reused. This growth is dramatic for our population has increased 40 percent in the past 20 years to 180 million people. It is expected to increase a like amount in the next twenty to 260 million people with a water use estimated at 600 billion gallons of water per day. Much of this growth will occur in water-short areas which already practice some reuse. With water reuse comes increasingly stringent standards for the release of wastes to streams and ground water. We need to know how badly the streams are polluted; where the pollutants originate; how they act when mixed in a stream; their effects on the beneficial uses of water; and the changes which are occurring in the streams from year to year.

Accurate answers are needed to these questions to guide public policy in management of the water resource. Krause has said, "The Nation's health rests on our ability to accurately measure the pulse, respiration, metabolism, and blood pressure of the great hydraulic system of this country and translate it into terminology which will give the public adequate information on our streams and lakes." The answers are needed not only by cities and industries seeking sources of new or additional supply, but they are needed by public officials who are doing long-range water planning, allocating water rights, and enforcing a water quality program. They are needed by persons concerned with agricultural development, fisheries, navigation, recreation, and wildlife.

Even as there is no justification for gross pollution of waters, there is no need for requiring treatment far in excess of the requirements for the beneficial uses of the receiving waters. To keep treatment needs in balance with a reasonable factor of safety requires regular, continuous charting of the quality of water in each stream. Today great gaps occur in the knowledge of the conditions of the Nation's streams.

### Indices for Measuring Pollution and Difficulty of Applying Them

The scientific base for measuring bacterial pollution was established by Pasteur and reinforced by other great bacteriologists of the late 19th and early 20th centuries. With the understanding of the role of bacteria in the transmission of filth-borne diseases, came their use as an indicator of pollution. At about the same time, a start was being made in measuring chemicals in surface waters. To the bacterial and chemical yardstick was added oxygen demand and aquatic plants as measures of pollution—the former as a determinant of organic matter which uses up oxygen and the latter as they aid in burning up pollution.

The bacterial yardstick has been expanded to include the viruses as their role in disease transmission has been better understood. The laboratory methods for finding viruses are laborious and expensive so that very little information is available about their occurrence in sewage effluents and streams. More is needed, particularly in waters used for recreation and public supply. The survival of the infectious agents depends upon many factors such as sunlight, temperature, nutrients in the water, and amount of dilution. All of these factors must be considered in assessing the water-pollution problem for a particular stream.

The measurement of chemical pollutants has been made infinitely more complex by our technological development with new products for the convenience and comfort of Americans. The manufacture of many of these new products has created new wastes. Most of these wastes are mixtures of numerous chemical substances which are difficult to identify and may resist treatment by conventional or known methods. Others such as nitrogen and phosphorus provide food for aquatic plants the same as they do for your lawn. They stimulate the growth of the plants which later die, decay, and give off taste and odor-producing substances. Any evaluation of present-day chemical pollution must include data about wastes from the new organic chemicals such as detergents, insecticides, weed killers, and a great variety from chemical manufacture. This means then, that in order to assess the chemical condition of any river, the chemical determinations must be tailored to the wastes discharged to the particular stream system.

The need for measuring a new pollutant—radioactivity—was signalled in Chicago on a dreary December afternoon in 1942 by the first sustaining nuclear reaction. This contaminant can be tolerated only in minute amounts. It is important in soil as well as in water and its long-term significance cannot be overestimated. Unfortunately the Federal and State governments were slow to make extensive measures of radiation as it existed before bomb testing, but some start has been made toward closing this gap.

## What We Know About Present Sources and Levels of Pollution

### *Natural*

In assessing the water pollution problem, some attention must be given to what we know about sources and levels of mineral and silt pollution. The levels vary from very soft to highly mineralized waters and from very clear to extremely turbid streams. When the early settlers viewed the Missouri River, they observed that it was too thick to navigate and too thin to cultivate; so some silt pollution has been occurring long before cultivation accelerated the rate.

Today, in spite of gross organic pollution to the Potomac River, its most serious pollution problem is siltation.[1] Its annual silt load may be as much as 40 million cubic feet. The Corps of Engineers has estimated the sediment yield of the Mississippi River at half a billion tons per year. Perhaps 50 to 75 percent of this erosion can be stopped, but the cost is estimated at more than $6 billion. The removal of silt will benefit fishing and recreational uses of streams, but it may introduce new problems to municipal and industrial water supplies which are worse than the old, particularly those associated with aquatic plant life and organic pollution. Less turbid water below the dams across the Missouri River has stimulated the growth of algae and other taste- and odor-producing organisms, for example.

---

[1] Wolman and Geyer, "Consultants Report to the Interstate Commission on the Potomac River Basin", 1958.

Pollution from the leaching of natural salts has limited the use of large quantities of water in the Arkansas and Red River valleys. Here the solution of natural beds of sodium chloride and gypsum made the waters so hard and offensive in taste and physiologic action that Dallas residents bought drinking water in milk cartons rather than use the city supply during its 1955–56 water shortage. In these basins the States and the Public Health Service are cooperating in a program to determine the sources and amounts of "natural" pollution. Preliminary estimates indicate that natural pollution contributes 4,000 tons per day of common salt to the Red River and 13,000 tons per day to the Arkansas River above Tulsa, Oklahoma.

The water which seeps back into the streams from irrigated lands adds to the pollution problem because it dissolves soluble minerals from the land and returns to the stream. Some local studies are being made, but so far as is known, no country-wide evaluation has been made of the problem. With new lands being brought under irrigation each year, a full assessment of this source of pollution is needed.

### *Man-Made*

Administration of the Federal water pollution control act has required better information on sources of pollution, amounts, location, and treatment. The States and the Public Health Service have cooperated in assembling this information. The Conference of State Sanitary Engineers is working now with the Public Health Service on an inventory of sources of pollution and treatment which should provide the most accurate data so far. Existing information is relatively accurate for cities, but it is sketchy for the 25,000 wet industries with separate waste outlets.

Facts about the size of the municipal waste treatment problem and construction trends for the past 10 years do much to indicate what will be required in the years immediately ahead. The tables which follow show that the cities had difficulty in keeping abreast of increasing amounts of sewage while cutting away at the backlog of untreated wastes from existing sewers. Industry had even more difficulty in eliminating the backlog and keeping up with the spiraling production which reached the $500 billion level for gross national product.

**TABLE I.**—*Sewage Treatment Needs 1950 and 1957* [1]

| Need | Number of plants | | Population served (millions) | |
|---|---|---|---|---|
| | *1950* | *1957* | *1950* | *1957* |
| New plants | 4, 209 | 2, 851 | 31. 0 | 18. 7 |
| Replacements | 722 | 1, 123 | 3. 5 | 3. 4 |
| Enlargements | 1, 745 | 1, 630 | 25. 7 | 25. 4 |
| Totals | 6, 676 | 5, 604 | 60. 2 | 47. 5 |

[1] Hollis & McCallum, "The Pollution 'Balance Sheet'—Where Do we Stand". *Wastes Engineering,* Oct. 1960.

In terms of people, 90 percent of the 5,604 communities have less than 10,000 population. Only 3 percent are cities of more than 50,000, but they contribute 60 percent of the pollution. This group of about 150 cities includes 29 million people. Seventy-five of these, with a population of 12 million, do not treat their sewage. Convincing the public to spend for this purpose when many other needs are making demands upon their financial resources is a major problem.

The 1957 inventory shows raw sewage being discharged from nearly 22 million persons. Over 60 percent of this occurs in the Northeast, North Atlantic, Ohio, and Southeast river basins. The most work is needed in these four areas of the United States.

*Table II. Municipal Sewage Works Construction 1957–1959 with portion receiving Federal aid*

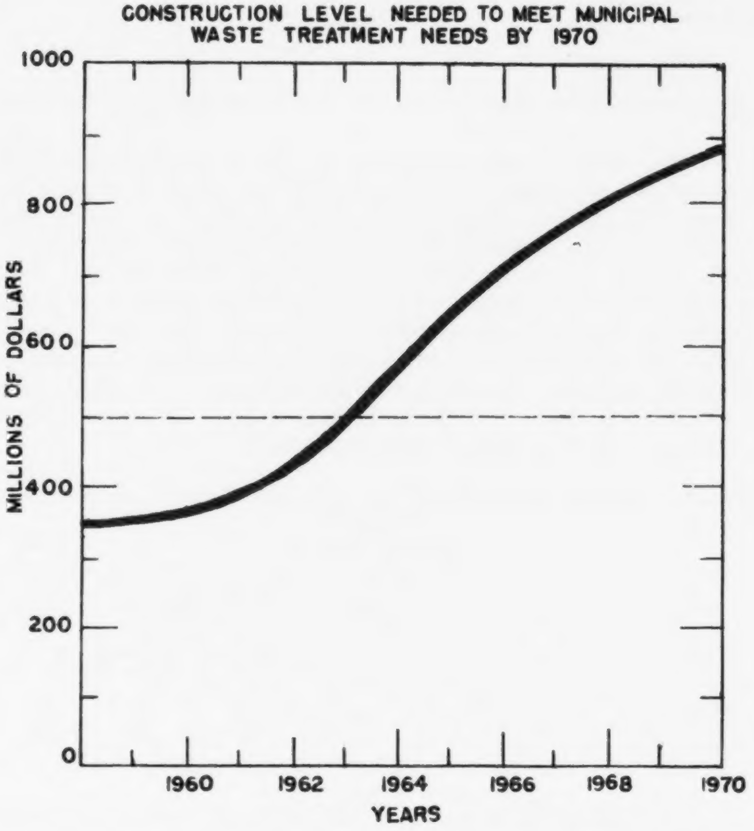
[In Millions of Dollars]

| Year | Constructed with aid of 660 funds | Constructed without Federal assistance | | Total |
|---|---|---|---|---|
| | | Amount | Percent | |
| 1957 | 119 | 232 | 69 | 351 |
| 1958 | 159 | 230 | 59 | 389 |
| 1959 | 139 | 210 | 60 | 349 |

Table II shows the portion of municipal sewage treatment projects receiving assistance in 1957, 1958, and 1959. Note that nearly two-thirds of the money spent for construction in those three years was for projects which received no Federal aid. While this discussion is aimed primarily at the physical problems of assessment, funds to aid only a part of the eligible cities are a deterrent to the construction of facilities at a rapid rate. A constant tendency is at work to slow the construction to that rate which can receive Federal aid.

The Korean war and accompanying material shortage slowed progress in the early 1950's, but there has been a steady acceleration since. Even then, the deficit represented by the 5,604 cities in Table I combined with natural obsolescence of existing plants and population growth will require a higher construction level each year of the next 10. The figure below shows the construction level needed to catch up with municipal needs by 1970 as estimated by Hollis and McCallum:

FIGURE 1



Any comparison between municipal and industrial wastes is difficult because the characteristics of the wastes are different. Those industrial wastes which are primarily organic in nature are comparable, but chemical wastes with relatively stable compounds are more difficult to degrade and measure by the usual indices. On the basis of the number of sewers discharging, Steffen shows a 64 percent increase during the past ten years in industrial waste treatment and a 44 percent decrease in industrial waste treatment needs.[2] A survey now under way is expected to provide more accurate information. On the basis of present information, industry needs are estimated at 6,000 new projects and a cost of $2 billion, including in-plant changes. This adds $575 to $600 million per year to the price tag for municipal sewage treatment—or a total of $1.2 billion per year. An expenditure of this order should wipe out the backlog and keep up with the projected expansion.

---

[2] A. J. Steffen, "Where Does Industry Stand in Water Pollution Control". Presented at annual meeting of Water Pollution Control Federation, Oct. 3, 1960.

The size of the problem caused by radioactivity can only be guessed. Serious contamination may occur from some uranium processing plants, but the major problem is probably associated with the disposal of high level wastes from nuclear power reactors. This problem is of such a magnitude that many persons believe it is the major hurdle to the widespread peaceful use of atomic energy.

Information about the status of waste treatment at Federal installations is also sketchy. While the impression may not be documented, many persons believe that the Federal agencies, particularly the military establishments, have lagged behind municipal and industrial practice. This impression has been fostered by experience at such places as Sioux City, Iowa, where the air base is discharging untreated sewage adjacent to the city which is under Federal order to treat its wastes.

Concern about the matter caused the President last May to ask Secretary Flemming to undertake a program for the cleanup of pollution at Federal installations. The President said, "The Federal establishment must take every possible action to make certain that its own house is in order with reference to the problem of controlling and preventing stream pollution." A survey is under way to determine the facts and an early report is expected.

### *What We Should Do*

It is probably small consolation to you that other countries also have a pollution problem and that they are concerned about it. A recent account from Russia reports that "fish and vegetation are perishing. The health of the people is in real danger and all of this is taking place because the sanitary laws are being violated by too many administrators". The article goes on to report that fish are being killed and human health endangered in 225,000 miles of rivers. The official organ of the Young Communist League in Russia, *Komsomolskaya Pravda*, tells of gross pollution of the northern Donitz River. Industrial production is said to be affected. I don't know what the Russians plan, but our work is cut out for us.

Assessment of this problem gives convincing evidence that action is needed, both to get additional data for better understanding of the problem and for acting on the basis of data we now have. There is ample basis for concern that the expected population increase and growing concentration of people in metropolitan areas will worsen the pollution problem.

The following recommendations are concerned with improving our knowledge of the problem:

1. Encourage the States to develop water monitoring programs for bacteriological, biological, chemical, physical, and radiological quality as they are related to stream flow. This work should be coordinated with the efforts of an expanded National Water Quality Network.

2. In monitoring programs, every advantage should be taken of automatic recording instrumentation.

3. Much more information should be collected upon the effects which changes in waste loadings have upon the actual quality of water in streams, especially where some of the contaminants resist biological degradation. More data should be collected on the condition of streams both before and after pollution abatement.

4. Develop a program to determine the quantity and characteristics of industrial wastes discharged.

5. Study the problem of return flows from irrigated lands.

On the basis of current knowledge about the pollution problem:

1. The construction of municipal waste treatment facilities should be expanded to the $600,000,000 per year level at once, with continued increase to keep up with population growth and to abate old pollution by 1970.

2. A similar program of expansion should be applied to the wastes of industry. This can be accomplished by strengthening enforcement activities of the States with Federal intervention when the States fail to act; a national program of public education; and a State or Federal program of grants or subsidies through rapid tax amortization.

3. The data show that some regions are doing a better job of pollution abatement than others. Should some penalty be applied to the laggards or some incentive to the leaders? Perhaps Federal grants should be withheld from the communities which have delayed action until the water pollution control authority issues an order.

4. Each Federal installation should be required by Congress to treat its wastes in accordance with the standards for cities and industries in the area with 1964 set as the target date for providing some treatment at all such places.

## DISCUSSION

T. M. Schad
***Staff Director***
***Senate Select Committee on National Water Resources***

Mr. Metzler has presented a very clear and concise assessment of water pollution problems facing the United States as we enter the decade of the 1960's. He has given emphasis to the physical magnitude of the task of providing needed waste treatment facilities, and to the gaps in our knowledge of how to deal with pollution problems. The recommendations of his paper appear to summarize the existing thinking in this field, and it is to be hoped that one of the outcomes of this Conference will be the development of positive programs for carrying them out.

Another major aspect of the pollution control problem needs to be brought out—the requirement of water for dilution of effluent from sewage and industrial waste treatment plants. Even where treatment plants provide the highest economically attainable degree of treatment, there is a need for water to dilute the effluent. Requirements for dilution can be considered under three principal categories, as mentioned by Mr. Metzler. First, where there is incomplete treatment, dilution water is needed to provide oxygen for biological reduction of the remaining wastes. Second, as the percentage of treatment increases, the effluent contains increasing amounts of plant nutrients containing phosphorus and nitrogen. Unless they are removed by costly methods of treatment, they stimulate the growth of algae, which, as it decays, demands oxygen for biological reduction which must be supplied by dilution water. Third, as the persistent chemical wastes increase in quantity and strength, dilution water is needed to keep them at low enough concentrations that they will do no harm.

It seems clear that all three of these requirements will increase along with our industrial civilization. They call for increasing requirements of water for dilution. For example, in England, where because of more concentrated pollution loading, waste treatment generally has to be carried on to a higher degree than in this country, a standard dilution requirement is 8 to 1.

As a part of the studies for the Senate Select Committee on National Water Resources, an attempt has been made to project requirements for dilution water needed to take care of the effluent from the waste treatment plants that will be needed to handle quantities of waste expected 20 years from now. This is estimated to be almost double those of today. A report on the methods used to determine requirements for dilution water has been issued by the Committee as its Committee Print No. 29. The method is rather complicated for discussion in detail at this meeting, but it provides a basis for making rough estimates of dilution requirements for the three categories previously mentioned. On the basis of these requirements, it is possible to develop relationships between the degree of treatment for a given level of waste, and the amount of storage required to provide water for dilution during low-flow periods. More work needs to be done with the method before it can be used for actual design of waste disposal systems. It needs to be checked against actual field conditions. Standards of tolerance, that is, standards of permissible chemical pollution and standards of desirable dissolved oxygen content, need to be developed and agreed to. Further work needs to be done to reach agreement as to what percentage of the time an excess of pollution or a deficiency in dissolved oxygen below the normal standards can be tolerated. For the purposes of the committee's studies it was assumed that a residual of 4 parts per million of dissolved oxygen should be maintained as an average one hundred percent of the time.

Using the method developed for the Select Committee, the amount of river regulation needed to augment low flows to an extent sufficient to provide the required amount of dilution water can be determined for various degrees of waste treatment. Generally speaking, the amount of dilution water required is inversely proportional to the degree of treatment. For the entire country, it appears that from 200 to over 300 million acre-feet of additional storage would be required between now and 1980, over and above the approximately 280 million acre-feet in existence in 1954, to meet the needs for water for dilution and the increases in consumptive use of water that can be anticipated by that time.

Therefore, in addition to stepping up the rate of construction of municipal sewage and industrial waste treatment facilities to a level estimated in Mr. Metzler's paper to aggregate $1.2 billion per year, additional attention will have to be given to the needs for storage to provide flows for dilution. Studies made for the Select Committee indicate that the capital cost of the storage program to meet both consumptive use and dilution requirements may be about $600 million a year between now and 1980, under the most economical program, which would involve substantially higher annual expenditures for treatment works than $1.2 billion. There are many possible combinations of degree of treatment and quantity of storage for low flow regulation, but the essential points to be kept in mind are that there will be a need for storage for low flow augmentation for dilution, along with the additional treatment works, and that the cost of such storage will probably be in the order of magnitude of about one-third the cost of the waste collection and treatment facilities. Details on this subject are covered in a report made to the Committee by Resources for the Future, which is published as Committee Print No. 32 by the Select Committee.

Mr. Metzler mentioned that there was no need to provide excess treatment, or treatment in excess of the requirements, for the beneficial uses of the receiving waters. I wouldn't want to argue with this as a logical statement on this subject, but I hope that the fear of making rivers too clean will never hold back the construction of treatment facilities. Even if excess capacity is provided, the rate of growth of the Nation's waste-producing activities is such that they will soon make full use of any excess facilities that there is any reasonable possibility of being able to finance and build.

One aspect not specifically mentioned by Mr. Metzler, but which will need considerable further study, is the problem brought about by discharge of pollution into estuaries. In the studies for the Select Committee we were unable to find that very much research had been done in this field. Studies have been made of the Potomac and the Delaware, and some of the other tidal estuaries which receive relatively large quantities of sewage, but these studies leave much to be desired. There is a need for a great deal more work on this problem to permit adequate standards to be applied for discharge of wastes into tidal estuaries.

One further type of pollution not previously mentioned but which will assume increasing importance in the future, is the heat released into rivers by the use of water for industrial and power plant cooling purposes. There will be more and more instances of such thermal pollution as the number of thermal-electric power plants, whether they be powered by fossil or nuclear fuels, increases along our waterways. The principal adverse effect may well be on fish and wildlife, but the effect of heat on other types of pollution can be very great at times. Further study is needed to determine effects of heat pollution and its relation to other types of pollution.

Answers to some of the problems that Mr. Metzler and I have mentioned here today can be developed through the carrying out of the studies proposed by Mr. Metzler for increasing our basic knowledge of the pollution abatement problem. I would expand his recommendations by including recommendations for additional research into the problems of dilution requirements and development of alternative treatment methods. In closing, I would like to mention also the need for more adequate consideration to be given in the future to overall problems of water management for all purposes, including pollution abatement, as part of the planning for comprehensive development of water resources of the Nation's river basins.

# Impacts of Pollution on Health

DR. ROBERT A. KEHOE
***Director, the Kettering Laboratory of the College of Medicine, University of Cincinnati***

I would like to preface what I have to say by just a few very brief remarks for your orientation.

I have deliberately chosen to restrict what I am to talk about this morning to one phase of this subject and to its most difficult problem. I have done this partly because of the shortage of time. I have done it also, however, for the purpose of emphasis, and I trust that these reasons may be apparent as we go along.

This discussion will concern itself with three aspects of the general subject which seem to be the most pertinent for the purposes of this Conference, namely, (a) present chemical hazards to human health associated with community water supplies, (b) similar hazards which may be anticipated in the foreseeable future, and (c) what is to be done to eliminate or control these hazards.

## Present Hazards of the Pollution of Water With Chemicals

With respect to present threats to the public health, it must be agreed that there is little factual information on the ill effects of the pollution of general community water supplies, other than those that stem from the presence in the water of pathogenic microorganisms and parasites. Most of the available information about the effects of the chemicals which may occur in, or find their way into, water supplies, has come from experience with them in other relationships, as in industry or in therapeutic or forensic medicine. What is known about them in connection with drinking or culinary water has been derived from the experience of individual or small groups here and there, who have suffered acute illnesses in consequence of the presence of some uncommon, natural constituent (fluoride, selenium, hydrogen sulfide), or because of the accidental contamination of the water of a well or spring or receptacle, through the use of an improper container or pipe line [lead-lined or galvanized (zinc) tanks, lead or cadmium-coated pipes, glazed or painted surfaces], or from the spillage or seepage of some foreign chemical into it (gasoline or other organic liquids in storage). There is virtually no real information for or against the thesis that the contamination of many of our urban water supplies with low concentrations of a host of industrial chemicals constitutes a present danger. Moreover, there is no reason for believing that the facts in this regard are likely to be established soon. There have been very few satisfactory investigations of this general problem, and there is no general plan for such purposes.

Some years ago, at the behest of the Ohio River Valley Water Sanitation Commission, members of the staff of the Kettering Laboratory (Department of Preventive Medicine and Industrial Health, College of Medicine, University of Cincinnati), began a comprehensive search of the literature for biochemical and toxicological information on a series of chemicals that appeared to have fairly high priority, hygienically speaking, among the list of waste products that are being discharged into the Ohio River. It was anticipated that this work, in and of itself, would fail to be highly productive, since we had some knowledge, in advance, of the paucity of knowledge concerning the effects of the prolonged absorption of small quantities of ingested chemicals. Toxicologic investigations, except in relation to industrial hygiene and occupational disease, have not extended into this field to any important extent. Nevertheless several years of hard work went into these bibliographic researches and produced a series of some 28 reports, more impressive for their intent, format, and binding than for their yield of the desired information. In these reports are assembled the pertinent data concerning the following metals or cations—aluminum, ammonium, cadmium, chromium, cobalt, copper, iron, manganese, nickel, tin, and zinc; on the following anions—cyanide, chloride, fluoride, sulfate, and thiocyanate; concerning arsenic both as cation and in the anionic radical; and on the following organic compounds—meta-, ortho-, and para-cresol, naphthalene, phenol, and pyrridine.

In order that there may be no misunderstanding as to the relative importance of these materials in relation to the public health, it should be pointed out that the likelihood of the presence of some of these substances in considerable quantity in the river water was a greater factor in their initial choice for study, than was their potential or suspected toxic threat. It will be recognized, however, in all likelihood, that, regardless of specific priorities, these elements or radicals deserved consideration. (May I interject at this point that we ought to know a little bit more about a number of things and in what form they are in this and in the other rivers. We undoubtedly have some representation in the Ohio River of every chemical that is manufactured and handled throughout the eight States through which this stream flows. These can be identified chemically. Their concentrations can be determined. And until we know this, this first basic information, we really don't know the extent of the problem. This is only the beginning, but even this we do not have to the extent that would be desirable.) It may be a source of dismay therefore, to many of those who are concerned with this general problem, some of whom may have seen these reports, to realize how nearly useless they are as basis for appraising the significance of most of these substances as pollutants of drinking water. Only two of the reports contain information from which sound and durable standards for human safety and well-being can be and have been recommended. These are, lead among the anions, and fluoride among the cations. For these two elements and their common inorganic compounds, we can adopt standards for water quality that are realistic and can be counted on to remain so for some time to come. This is true only because unusual circumstances have brought forth the comprehensive investigations required to produce facts on which sound judgment can be based.

A very few of the members of the foregoing list—aluminum, iron, tin, and chloride—may be relegated to low positions, from the aspect of public hazard, so that the information now available about them may be accepted as reasonably satisfactory for present toxicologic purposes (not necessarily for other qualities of water), but the hygienic questions that are being raised about the others cannot be answered.

It may be useful, at this point in our discussion, to digress a moment to point out a simple and obvious truth, which strangely, seems not to be fully appreciated. There seems to be a notion abroad that the matter of water pollution is an engineering problem; that the application of good principles of sanitary engineering is all that is required to solve it. Aside from the remote possiblity that the use of more or less orthodox methods of treating water will remove certain classes of contaminants completely just as a matter of course or of chance, this concept of the role of sanitary engineering is not a little lacking in realism. One might be blunt and label it as stupid. Certainly, the engineer will not be guilty of this oversight, for he, of all persons, must know the virtue of specifications which define what is to be achieved. Let us all be honest with ourselves. Specifications for human health and welfare, in relation to the common contaminants of many of our sources of water, do not exist, and we shall not be able to deal effectively with this problem of public health until they can be formulated on sound physiological facts.

Some idea of the scope of the investigative program and the volume of information that may be required to provide hygienic standards for a specific natural constituent or artificial contaminant of water may be conveyed by inviting your attention to a professional experience which has been shared with variously skilled members of the staff of the Kettering Laboratory. One item of our work has concerned itself with the limits of human safety in the absorption of lead compounds, and in solving this hygienic problem in its relation to both occupational and community life. For, because of the occurrence of lead in food, in beverages including water, and in the air, and in view of the variable type and severity of occupational exposure to lead, no standard for any one medium, such as the acceptable concentration of lead in water, or of any one occupational factor, such as the concentration of respirable lead in the atmosphere, has a true hygienic validity of its own, except as it takes its proper place in the entire environmental situation. Our investigations, initiated without much background or precedent, and conducted on the basis of trial and error, were wasteful, in retrospect, of both time and money. Gradually they gathered basic information and direction, and, after some thirty years of somewhat pedestrian effort, they have found solutions of some present problems, have revealed others, and have pointed out certain methods, not necessarily the best or the most expeditious, of attacking some of the future problems. Out of these investigations, valid standards for the permissible concentrations of lead in water, food, and the occupational atmosphere can be derived, and it is anticipated that such a standard for community air can soon be had. (These studies, which have provided this information perhaps in not the most efficient manner possible if we were to look back on it, have cost over a million dollars. I wonder how we get at this information for the thousand-and-one other chemical elements that exist in our streams and lakes?)

The foregoing experience represents only one example, in principle, of the situation with which we are confronted in the field of water pollution. Other examples, no doubt, will suggest themselves. A variant issue is furnished by the case of fluoride, in illustration of the fact that we are concerned here, not solely with the avoidance of public risk, but also with the achievement of a beneficial effect on human health and wellbeing. The problem of a suitable water supply for human consumption must involve the consideration of what elements or compounds *should be* contained therein, and in what concentrations, as well as what *should not be* present, or, more likely, what *may be permitted* to remain within certain limits of concentration.

Before us lies the necessity of acquiring a sound understanding of the physiological role played by the earth's mineral elements in the human organism, and their optimum as well as their tolerable concentrations in the human environment. At the same time, the host of chemical compounds which have come into use, together with the many which are added annually to the list, present a formidable, indeed a seemingly impossible, task for the medical investigator. Many of these chemicals, indeed most of them, will find their way into the food we eat and into the air we breathe, as well as into the water we drink, in traces or in more readily measured quantities.

Note: I have not gone on here to discuss radioactive materials in water for the simple reason that this is part of the general problem. It is not different in a number of respects except in one, namely, that this hazard is at the present time more readily appreciated and is also the more readily dealt with. Therefore, I have concentrated on those others which at the present time it seems to me we tend a bit to forget or to gloss over largely because of our enormous ignorance.

### Hazards of Water Pollution in the Future

Our discussion of our present situation has foreshadowed the future, with respect to the hygienic aspects of water pollution, and with particular reference to the introduction of new chemicals into the sources of water supplies. There is some justification or, at least, some excuse, for a certain tardiness in our detailed investigation of the physiologic background—the total metabolism in man—of the natural mineral constituents of the earth. Those, like man himself, are part of the matter and phenomena of nature. We have had faith in the good earth, and in this faith we have suffered some of its insidious buffetings with a lack of concern that has better betokened our religious forbearance than our scientific acuity.

When, however, one considers the increasing complexity of our technology, its further extensions, catalyzed by our growing population and the necessities of greater and more varied means of providing food, clothing, shelter and comfort, communications and entertainment, a discerning eye cannot fail to perceive the overwhelming artificiality of the future human environment. Out of this will come, inevitably, an enormous growth of the problems of waste disposal. How can we fail to appreciate the urgency of developing methods whereby the facts may be learned, and of establishing the facts as they are needed for our guidance in matters of human health and safety.

### Measures for Detection and Control of Hazardous Pollution

In considering what is to be done, it is clear from the foregoing remarks that the first step is the acquisition of sound information. (This says nothing about water that is used by domestic animals that become our food. They are not in the cities where the water has some chance of being purified. They are out where the water flows by them.) Let us be quite clear about this. We Americans are credited with having an undue faith in legislation and regulation; so much so, that it is alleged that when we have no idea what to do otherwise, we resort to legislative or administrative gestures, which have the flavor, at least, of piety. I am not impressed with the fact that we differ much from other organized national groups in human society. The fact is that man has always adventured far beyond his knowledge or even his awareness of his ignorance, and has always expected to be rescued, miraculously, from the consequences of his daring, or to be more realistic and less complimentary, his foolhardiness. Certainly in the present state of our understanding, and our ignorance of the threat which our technologic society is imposing upon itself, there is need to ponder, to plan, and to invest our time, our skill and our financial resources, in obtaining the basic information which we require for our own safety. We cannot and we should not halt our technological developments, until we can learn enough about their consequences to ensure our safety. (This may seem heresy to some. I think some realistic consideration of ourselves as a society and our general behavior will substantiate the essential truth of this. We shall not stop what we are doing to be safe. In this particular respect the slogan is not "Safety First." The slogan is "Safety Afterward.") Even if this were possible—and it is not—it would be unwise to attempt it. Rather, we must learn as we go. We must consider the potential consequences of our technology upon human health, and investigate such consequences with the same zeal and sense of necessity that we devote to the appraisal of its commercial and economic features.

Let me just say another word about this. Common notion has it that these things can all be investigated in advance of human threat in the experimental laboratory for experimental animals. This is a fiction, and we should recognize this fact. We cannot extrapolate with any degree of certainty or assurance from animal experimentation to human experience, in consequence of which I say we must learn as we go. The experimental setup in the community must be there before we can investigate it. We can throw around it reasonable safeguards, those which judgment suggests, but we cannot ascertain the facts except by the observance of the human animal within his experience.

The answer to these problems lies first in physiological, toxicological and epidemiological research, hand in hand with the development of specific potential hazards, whereby facts of hygienic significance can be established on a scale hitherto unapproached. The second step lies in the preservation, so far as possible, of uncontaminated water supplies and the regulation of drainage areas, as well as the disposal of wastes in streams, so as to limit the contamination of water sources within specified limits. The information required for these purposes cannot be obtained except by the combined and coordinated efforts of government and other public, as well as private, agencies, including those of industry. Much of the preservation of bodies of water and streams against pollution with industrial and community wastes must be accomplished through the cultivation of a sense of responsibility among citizens in private life, in industrial organizations, and in local, State and Federal agencies of government. Governmental regulation is a necessary function in the interest of general compliance with well-substantiated principles and procedures of good practice. In the long run, however, the responsibility for the maintenance of public safety from water pollution, as from other man-made hazards, is vested in the professional and technical people generally who have knowledge of these matters, and especially in those whose activities create the potential or actual threat to human health and safety. The investigative functions and responsibilities of government, in this field, while extensive, are not all-encompassing, but should be mainly catalytic and exploratory. Actually the presently available facilities for research in this field in this country are inadequate, and therefore it is not suggested that the efforts of government are likely to be expanded beyond their necessary or proper scope. Rather, the point to be made is, that in a free society which undertakes to remain free to develop as its individual and collective ingenuity and wisdom may dictate, the hygienic consequences of technical and industrial projects must be examined as a regular and necessary part of technologic research and development. The acceptance of this responsibility by industrial, as well as other groups, may well retard certain developments, and may render them more costly in their initial stages. On the other hand, the eventual cost to our society and its economy will be much less, and we shall achieve a degree of hygienic security more in keeping with our technological progress.

## DISCUSSION

### Dr. Russell E. Teague

***Commissioner, Kentucky State Department of Health***

The history of man's development, life, and progress is inextricably bound to the availability of water and his use of it. His very existence is because of it. In fact he is made of at least 70 percent water, and in order for him to maintain a healthy, biological status he must replenish his cells and intercellulor spaces daily with a new high quality supply. Like cities and industries he also uses water to carry off his individual body wastes.

A physician can't help drawing an analogy between the ten billion cells organized into a society in a single individual human body and the community, how it must use water for its chemical processes and its everyday business and also use water to eliminate its waste. There is no other way around getting rid of wastes, unless some other way could be found, other than the use of water; so we must use the water.

The future of the *society of man* absolutely depends upon how well and how rapidly he learns to control his aqueous environment. He must learn to use the available waters to eliminate the wastes of society as well as to provide an adequate, high quality, safe, supply for the maintenance of health. Future population growth, industrial expansion, agricultural use, the preservation of a biologic balance of life on earth, all depend on more knowledge and the use of it.

Even now we must close the gap between what we know about water and what we do about it with applied science if we expect to maintain a healthy, expanding society.

## Infections and Parasites

History provides a continued series of catastrophies due to waterborne diseases and epidemics. Water may play a part in the transmission of almost every infectious or parasitic disease known. Public health has made its greatest contribution in the prevention of disease and increasing the length of life by the relatively recent techniques of waste treatment, water management and water treatment. Cholera, typhoid, the dysenteries, malaria, and nearly all of the other infectious diseases have decreased or are under some degree of control in developed countries. Recently, however, many epidemiologists have pointed out that what has been done to control the enteric waterborne epidemics, such as typhoid and cholera, probably was not sufficient to control a considerable number of the virus infections.

In a critical examination of the literature (1922–1959), Kabler enumerated the various organisms found in sewage and compared the efficiency of various treatment processes. Almost all bacteria, fungi, parasites, and viruses found in raw sewage were found in the treated effluent with all types of treatment. The bacteria of typhoid, paratyphoid, cholera, salmonellosis, tuberculosis, anthrax, and tetanus, all of the viruses studied including poliomeylitis and Coxsackie, the worms, namely, tape, round, hook and pin worms along with schistosomes, were found to pass through treatment in all cases, though in lesser numbers; nevertheless they came through.

Kelly and Sanderson, studying sewage in the summer and fall of 1957 found over 166 strains of viruses. They concluded that secondary treatment by trickling filters without chlorination is inadequate for virus destruction; activated sludge was more effective but not complete.

It seems that "Time Down Stream" after treatment is very important. With sufficient time and distance most of the harmful organisms disappear. However, because of many other variables we can only consider this factor as relative. Even a water intake with treatment up-stream to a city with sewage outfall below is not assurance of safety. A flood with back-stream flow can cause epidemics. Epidemics of infectious hepatitis have occurred in this manner.

Water purification for domestic use still has its defects and faults. The greatest of these possibly is the human element of operation. Too often water treatment plants are operated by improperly trained personnel (personnel turnover is too great for safety) and in many if not most States the sanitary engineering, inspection and supervisory personnel are inadequate in number, inadequately paid, and inadequately trained. Frequency of inspection and laboratory control is in many places grossly inadequate to assume complete safety from waterborne epidemics. The conscientious health officer today may very well feel that he is skating pretty close to the thin edge of safety in this respect.

## Toxicity

Of the thousands of known toxic substances being manufactured and used in all of our living and manufacturing processes today, very little information is available. From all sources on toxicity effect in drinking water a very limited number of compounds, less than 500 in number, are considered in the literature.

The available toxicity data (mostly developed from studies on air in a select environment on healthy adult workers) are relatively large and provide a basis for most of our knowledge on toxicity, both on acute and chronic effects. No single food is consumed in as large a quantity or as frequently as is water. Further, other foodstuffs are exposed in many instances to water, both in preparation and in cooking. Water is used by the entire population from infancy through old age and it is a well-known fact that the toxicity of a substance varies radically with age. Infants might require 1/20 the amount of a material to exhibit effects of toxification.

I point this out to show how difficult it would be to do epidemiological studies on groups of population and have an effective control group over a full lifetime or span of life to determine the long-range toxic effects of some of these substances.

Some of the factors which intensify the problem in water pollution control are relative biological stability of the type of the compounds being manufactured, the increased number of these compounds and the increased public acceptance resulting in an extremely high usage of the compounds. Synthetic detergents made their first important appearance on the domestic market in 1947. In 1956, 455 million pounds of synthetic detergents were used. Insecticides, herbicides, fungicides, rodenticides, plant growth regulators, and other agricultural control products in commercial use now exceed 170 different compounds, with this list increasing in number every year. From the advent of the first organo-insecticides of commercial importance (DDT in the 40's), the compounds have become increasingly stable to biological attack and persistence in water now exceed months. The quantity of insecticides used in a single year is estimated to be in excess of 1 billion pounds to 100 million acres, or approximately 10 pounds per acre.

It is known that many of these compounds gain access to the streams and affect fish life adversely. Some authorities feel that the water is safe for domestic consumption if no acute or chronic effect is observed in the fish population. However, this might or might not be true because of modifying factors such as chelating compounds which can increase or decrease the toxicity of a given metal. Also, carcinogenic compounds cannot be evaluated adequately from the effects on animals other than the animal under study. No chemical carcinogen exposure or dosage limit have been described for the lifetime of man, and the role of co-carcinogenic substances is extremely hazy.

The toxicity of inorganic substances which exhibit chronic toxicity effects of a severe nature, that is, with a concentration of less than 1 part per million, include the following: antimony, arsenic, beryllium, bromate, cadmium, chlorates, chromium, cobalt, gold, iodide, lead, lithium, manganese, mercury, nickel, phosphorous (yellow) radium, selenates, selenites, tellurates, tellurites, thallium, and thorium.

Many of the organic substances exhibit severe chronic toxicity. These can include the following classes of organic substances: aliphatic unsaturated acid amides, aromatic polyamines, amidines, aliphatic unsaturated nitrates (cynides), aromatic hydrocarbons, aliphatic unsaturated halogenated hydrocarbons, aromatic polyhalogenated hydrocarbons, and nitro compounds, both aliphatic and aromatic.

Many of these organic complexes are manufactured in large quantities and include the insecticides and agricultural control chemicals.

As far as is known, the only surfactant which exhibits chronic toxicity is the cationic type of quaternary amines.

From this discussion of the toxicity of compounds which can gain access to water, it can be seen that the knowledge of the subject is extremely limited. The synergistic and antagonistic effects, the lack of data on the toxicity for whole populations and the extreme difficulty of procuring this information are in themselves of great concern to public health officials.

The Association of State and Territorial Health Officers appointed a subcommittee 3 years ago. From the subcommittee we came up with one recommendation which I should like to see implemented from this conference.

There is no central collecting agency for all of the information that is available to us on contaminants. We recommend that the United States Public Health Service assume the leadership in collecting all the information available from the other Federal agencies and other institutions of learning in this country and provide all the information that is available to the administrators of water control in regard to contaminants. That is, criteria, standards, methods of testing for, and the maximum safe concentrations.

Now, this is a terrifically big order. It may take hundreds of years to get. It may cost billions and billions of dollars. But someone ought to be collecting and putting together what is known and what we can find out about the effects of these contaminants.

### Radioactivity

Ionizing radiation in any amount, however biological cells may be exposed, is thought to be harmful. Magnitudes in fresh water today are in general considered as insignificant. However, attention must be given to future use and disposal of radioactive materials.

### Conclusions

To insure adequate, safe, high quality water for optimum health protection and permit an expanding society free from water-borne illnesses we must:

a) shorten the lag between what is known about water control and what is done;

b) maintain better sanitary surveillance of waste treatment and water purification facilities;

c) have more information on the epidemiology of water-borne diseases, particularly as related to many virus infections;

d) obtain more information, both immediate and long-range, on the effects of toxic substances in water, on individuals, and on population groups.

## Panel I

### General Discussion

**Mr. METZLER.** This question was asked by Mr. A. F. Dappert of the New York Water Pollution Control Board: ***"In the assessment of water pollution problems should not the problem of pollution from vessels, water craft of all kinds, equipped with marine toilets be given an increasing emphasis and attention?"***

He has raised an important point here that is of concern particularly to those cities and those States that are bordering on navigable waters.

Yes, I do believe this, and to show that this is more than just words, as a chairman of the Conference of State Sanitary Engineers I have instructed a committee to make a study of this important matter. The chairman is the State Sanitary Engineer from the State of Michigan, and we expect working cooperatively with some of the water recreation groups and the Public Health Service to have an answer as to what can be tolerated or, rather, what should be done about this problem. Even inland States such as mine are finding that this is beginning to be a problem with more reservoirs for storage and power.

**Mr. SCHAD.** This question is from Ralph H. Baker, Jr., Florida State Board of Health. The question is: ***"You referred to algae as a result of increased nutrients. In referring to this you inferred that the algae would also be considered as a contaminant. Please explain."***

I didn't mean to infer algae itself was a contaminant, but as it grows and decays it uses up the oxygen in the stream, and it's the dead algae you might say that becomes pollution, just as any other type of organic material that decays. That's what I was referring to, Mr. Baker.

**Dr. KEHOE.** This question was asked by D. E. Reed of the Cook County Clean Streams Commission, Forest Preserve District of Illinois: ***"Have the present concentrations of detergents in streams caused any demonstrated damage to water supplies for human use?"***

This is not the easiest question in the world to answer. I think, however, that it's fair to say that the detergents in streams, generally speaking, have been more of a nuisance than a hygienic problem as far as man is concerned. The concentrations involved are in the main fairly low, and the problem of toxicity here seems not to be great. I think it is quite fair to say at the present time that this is not one of our more important problems from the point of view of human health. It is, I believe, a more important problem in terms of other considerations which are not within my province.

**A DELEGATE.** Let me question that answer. I think it is a rather important problem as it travels through the ground and gets into the water supplies.

**Dr. KEHOE.** I know of no information at the present time that would indicate that this has been a significant problem in terms of human health. I'm not saying that it isn't a problem. I'm simply saying again, that such information as we have suggests that this is not a very important problem, hygienically speaking. This does not mean that all the information is in.

**Dr. TEAGUE.** I have one question here from Abe Eldib of the Esso Company: ***"What is the exact nature of the study which established that quaternary cationic amine detergents are toxic?"***

I don't know if I can answer it. I don't have the reference here. I am not thinking of it as a detergent. There was one substance that came out which was used for hand washing that is listed as a toxic substance, but I don't have the references with me.

I'll be glad to look it up when I get back and write to Dr. Eldib.

**Mayor McCANN.** Thank you very much. Will the gentleman who was so rudely interrupted earlier stand at the mike and introduce himself to this panel group, please?

**The DELEGATE.** The question I want to put is to Dr. Kehoe, on the statement that detergents are not toxic, but certainly they are more than just really a nuisance.

It has been found that they carry through unchanged in the substrata for very long distances. At least in the East, in subdivisions and developments, or where a number of these houses are built close together and have wells, the wells after even a period of a few years do show up detergents to such an extent that the water supply is really unfit for use and people are very much hard put to get drinking water or try to get a new supply. I think detergents have got to be given more than just a passing nuisance consideration.

**Mr. METZLER.** This question is from Mr. Svore of Dallas: ***"Would you care to comment on the need to treat sewage to a degree beyond that needed for present-day use of the river downstream from the treatment plant?"***

I think in my prepared remarks I said let's don't impose standards far in excess—that is, a great distance in excess—of that needed and justified by the downstream water users. There certainly is a need to treat wastes to a degree greater than that required by the immediate usage. Now, how far in the future depends upon the rate of development and how fast the water uses are growing. One needs a cushion. You can imagine the position in which the pollution abatement authorities would be placed if each city and industry up and downstream were treating at just the level which was satisfactory to maintain that stream for the various beneficial uses. The next industry that comes in or the next city that expands its population would start a chain reaction which would require every one of the polluters who were treating their wastes to increase the degree of treatment. This is not practicable. On the other hand, treatment for treatment's sake should be avoided. We have enough places for the tax dollar, for the investment of money in good public works, that we do not need to build facilities that are not going to be needed, that will not be needed to their full capacity, for the next 10 or 20 years.

I have a question from Mr. Bill Towell of the Missouri Conservation Commission: ***"Why do you consider return flows from irrigated land any greater a pollution problem than runoff and percolation from natural precipitation?"***

This certainly is a good question, and I did not mean to indicate that pollution from natural runoff and precipitation is not an important matter. This depends again upon the areas of the country. In general, however, the big tonnage of pollutants in areas where we have high-quality water may be carried back by this washing of irrigated land.

As many of you know here better than I, when you apply irrigation water to land in order that it may not become clogged and nonirrigable over the years, it's necessary for some 20 percent of this water to wash through the soil to wash these salts back into the receiving stream. There certainly are areas of the country now where streams are highly mineralized only because of the return flows from irrigation.

There's a good example in my own State where on the Arkansas River the irrigation in Colorado increases the salinity very substantially and makes the water in western Kansas not usable, water that otherwise would be highly desirable for most uses.

This is a question from Mr. H. T. Silverman, of the Crucible Steel Company: ***"Is it practicable to control pollution by the adoption of uniform national standards of water quality without considering varying local needs and waters?"***

I don't see how one could possibly think that it's possible to set down a national standard to follow in connection with all streams. I believe very much in tailoring the amount of pollution abatement to the uses of the stream.

If one could imagine, for instance, the quality of waste, of mineralized waste, which you might allow to go into some stream such as the Arkansas River in Oklahoma and compare this with the waste that you might allow to run into a small water-supply stream, there is no doubt but what the same standards cannot be applied to the stream that is already highly mineralized from natural flows and to water which is of very good quality.

I do not believe it's possible to apply national standards. You need to develop the standard for every river system; these standards should not be so inflexible but what they can be changed as the need changes.

Mr. Sol Pincus has asked this question: ***"In assessing the water pollution problem, is not basic consideration necessary to reducing the tremendous unnecessary waste of water in our communities through leaky mains, unmetered systems, in some instances amounting to 30 percent of the entire supply? Is not a national survey of water waste needed to bring attention to this phase of the problem?"***

Mr. Pincus, you said that better than I could possibly say it. There just is no doubt but what there needs to be more attention given this problem and I wonder if the fact that your home city is New York City had anything to do with your asking a question like this.

About a year ago at the American Public Health Association meeting in Atlantic City, in talking to a group of public health people, this was one of the problems which I pointed out. There is no justification for purifying water and then wasting it into the underground or into the outcrops in our streams. This is not only very expensive but it is very wasteful, and as Americans we really are quite wasteful of this important resource.

This is another tool which we have to increase the net available water supply to the people of the United States.

**Dr. KEHOE.** This question was asked by Dr. Abe Eldib of the Esso Research and Engineering Co.: ***"Should scientists wait for the estab-***

***lishment of manifestations of pollutants on health before they attempt to find new methods to remove pollutants?"***

The answer quite clearly is that we should not wait until we have had manifest effects of a serious sort. We do not have much information at the present time on the effects of many potentially toxic chemicals in water supplies except to the extent that some relevant information has come from industrial experience, where populations under medical supervision can be studied, and where the incidence of disease can, hopefully, be established. In this way we are very likely to have information which we can apply, at least with some faith, to the general population.

But how do you establish in a large community the influence of insidious chemical agents on the health of the people? Often this can only be done by long, elaborate, carefully-carried-out observations over considerable periods of time in order to establish that the incidence of illness has been increased within the time period that is represented by the presence of pollutants.

My point is that we must adapt our epidemiologic methods to these problems. We do not have epidemiologic methods at the present time to deal with anything other than fairly dramatic forms of disease. As to chronic diseases, we will have to develop methods, and there are those at the present time who are studying to develop such methods.

We certainly need more study of this sort on the populations that are concerned. But until we have information that indicates something in the nature of a hazard we are certainly hampered in our development of standards and the legal application of these standards in this field. One is required to obtain evidence other than mere anxiety concerning the possible effect of this or that or of the other contaminant or combination of contaminants.

Now, this clearly is not a satisfactory answer. The burden of my talk to you today was not to say that we have the information we can use in this respect, but that we have yet to obtain it, and in some instances we have yet to develop the methods by which such information can be obtained.

I shall be very pleased to have Dr. Eldib make his statement.

**Dr. ELDIB.** I have several reasons for asking the question Dr. Kehoe just attempted to answer; one of them is that as a member of private industry I know that some private industries want to help solve this problem. But like all other problems we tackle, we must have the incentive defined.

We may spend some of the Government's money, such as that given to industry as grants or contract research; also, we may want to spend some of our own. Now, in order for us to spend this money effectively we want to know what we are going to do with it. What is the problem?

In reviewing this field in the last couple of months I found there are about 15 types of compounds that may need to be removed. As a scientist one can think of 15 different methods to remove these things. I can think about foam fractionation, emulsion fractionation, thermal diffusion, freezing, zone melting, all sorts of techniques some of which are still in the infancy stage compared to other well-established unit operations.

Some people whom we need to convince and who are going to spend the money may say: "Why don't you wait until the effects of the different pollutants are established, and then when we know exactly what you want to remove we will go after it?" We may spend a lot of money figuring different ways for removing a certain pollutant; for example, a detergent or a wetting agent like a quarternary ammonium compound. Then after we go through all the necessary research we may find out, that after all, we didn't need to remove detergents since they may be proved later on as harmless.

We want very much to help. But it's very important for us—I'm talking about private industry now; I'm not talking about government because I can't speak for them—it's very important for us to have the effect of different so-called pollutants on health pinned down as much as possible.

For example, I was interested to hear the gentleman, the former Texan and now from New York, say that detergents really have an effect, and I plan to investigate this further with him.

**Dr. KEHOE.** It is something I would like very much to comment on, because it represents, in part, one of the central ideas in my talk—this problem as it relates to industry.

Let me point out that some of our industries have some of the best toxicologic information that is available. The company to which Dr. Eldib belongs, to my knowledge, has good sources of information and advice on toxic materials. They can have all the information that is available to any of us along this line, plus the fact that the experiences of this industry, in dealing with chemical materials, give it a source of information which is not always available to everyone else. The toxic materials that are used in industrial plants are very likely to reveal themselves to the industrial medical and hygienic groups including engineers.

The thesis that I would like to support is this: When *you* and *you* and *you* in industry have a problem of waste disposal, it may be as germane a technologic problem to you as is the production of the chemical which produces the waste. It is, I believe, the responsibility of industry in these situations to establish means of waste disposal that do not result in the contamination of streams in such a way that other action has to be taken at another and more remote point.

The proper time and the proper place to keep industrial wastes out of our waters in excessive quantities are at the time and point of their discharge from industrial plants. In many of our industries—not all, but in many—there is a concentration of some of the best brains, technologically and otherwise, to deal with the technologic problems of that industry. The industry should solve its own problem, and then the community does not have to solve it for industry.

I predict that within a relatively short period of time, the gathering of toxicologic information by industry for the protection of its own employees and for the protection of the community against air pollution and water pollution and soil pollution will have become a generally accepted responsibility of industry itself, either as a single individual organization or as an association of industries that have a common problem. This is the manner, it seems to me, in which prevention occurs at the point at which the problem is likely to arise. I think this is essential.

**Dr. ELDIB.** I think perhaps I didn't make myself entirely clear. We make every effort as far as I know to clean up our own wastes, those which may come out of a refinery or a chemical plant. But I was, however, speaking a while ago about our responsibility towards the overall problem. We want to be able to help solve the overall problem. We want to contribute this little drop so that if everyone contributes we'll have a bucketful of good.

If, for example, it is established that a chemical such as chlorophenol—I'm just picking an example—is detrimental to health, then we want to know about it so that maybe we can sit down as research people and find out a method by which we can separate this specific compound from waste water.

So I appreciate the fact private industry should solve its own problems, but we want to go beyond that and try to help solve the entire problem.

**Dr. KEHOE.** This point of view would certainly be welcome, and I would not want to disparage it.

Let me point out that if this company can develop a standard that will say, "This material should not be allowed to get into the water beyond this point of concentration; we have this knowledge; we have obtained this knowledge," such information can be published for the general good of the community. This is one of the ways by which our standards should come about. On the other hand, I would return to this point of view: that if it became the generally accepted responsibility of industry to keep its own house clean, we would not have all these problems to solve later.

**Dr. KEHOE.** This question was asked by Mr. G. T. Kellogg of the Arkansas Water Pollution Control Commission: ***"Would you care to comment upon the possibility of lead content in public water supplies which are used for recreation wherein motorboats using leaded gasoline are utilized?"***

With respect to the source of small quantities of lead which get into streams or lakes from gasoline motorboats using leaded gasoline, there are two possibilities. One of them is that some small quantity of lead may get into the water from the exhaust of the engine, and the other is that some of it gets into the water from the spillage of gasoline.

You will not need to be nearly as much concerned about the small quantity of tetraethyl lead which gets into the water along with gasoline as you will about the gasoline itself. You will not be poisoned by the lead in leaded gasoline, because the toxicity of gasoline is such, from the aspect of the acute effects, that you will not drink enough leaded gasoline in your water supply to get lead poisoning.

The other point is that the small quantity of lead which escapes from the exhaust of motorboats into the stream is a mere dribble compared to that in industrial wastes that get in from various lead processing plants along the stream. And even this is not of great importance, because our water supplies in general are not high enough in their lead content to be a source of danger except at localized sites where the quantities of waste material dumped into the stream maintain a significant concentration for a time before they are diluted. A large portion of the lead under these circumstances will also separate out as a sediment. This, perhaps is not good, but the lead is not likely to be carried along the stream in a sufficiently high concentration to be significant. Rather, we are more concerned about community drinking water in which the quantity of lead can add materially to the quantity of lead which we eat in food, and which we breathe from the air. We could very well have a standard here which is practical and easy to achieve, something of a very low order of magnitude which makes very little contribution to the total lead intake of the people in the community.

This problem, however, is not a significant one.

This question was asked by Mr. Bernard Garland, an engineer with the Fulton County Health Department, Atlanta, Ga.: "***Please comment on the effects and control or treatment of organic phosphates in water.***"

Fortunately, most of the organic phosphates are hydrolyzed in water and have a short period of persistence. It is entirely possible that water contaminated with organic phosphates, such as insecticides (small streams in localized areas) may for a time have significantly high concentrations of organic phosphates, enough to cause trouble principally in domestic animals. There have been such reports. On the other hand, this relatively short-persisting material is not as much of a problem in our water supplies as are those insecticides that are not easily hydrolyzed, that persist for a considerable period of time in the water supply.

I am not dismissing this as of no importance, but it is of minor importance, in the relative sense.

This question was asked by Mr. M. A. McWhinnie of DePaul University: "***Relative to detergents, chemists at food and drug***

***laboratories state that detergents show remarkable toxicity to chick embryos compared with other compounds based on per cent hatchability. Study just starting to be pursued."***

I think it must be admitted that we do not know all about the effects of detergents on aquatic life, and on the behavior of streams with reference to their own biology. At least I have no such knowledge that would in any sense be comprehensive.

If there is someone here who has that knowledge, I am sure the Chairman would be glad to recognize him in this relationship, because this is becoming increasingly controversial as a question, and those of us who have been concerned with this problem, from the point of view of the effects in water, do not have all the information that we need.

I think there can be very little doubt that the study that is being carried out is justified, and I would be hopeful that it would produce useful information.

All I can do at this point is to take refuge in the fact that I was here to talk about water from the point of view of the human toxicity, and I do not know all that should be known about the toxicity of detergents and their effects upon various other forms of life and various organisms. It is my belief at the present time, that the problem of detergents is one of logistics in handling water supplies, sludges, sewage material, and so forth, rather than one of toxicity. This is not to say that it does not justify study. I am giving you here an off-the-cuff opinion based on inadequate information, as I have warned you in my discussion.

This question was asked by Mr. Henry A. Stobbs, Industrial Wastes Engineer, Wheeling Steel Corp.: ***"Since the value of water is governed by its quality at the point of actual use, is there any reason why this principle should not be adopted as the basis for effective pollution control?"***

My answer to this is that there is very good reason why we cannot wait until we get to the point of use. This is particularly true in relation to industrial wastes. The individual who puts his waste in at the upper end of a stream has one problem. The individual who puts his waste in at the lower end of the stream, after everybody else has made his contribution, produces another problem. This problem has to be handled, I am convinced, from the point of view of specifications that will say to you in industry: "You cannot put more into this water at your plant than is wise, in view of the condition of the stream, the volume of water, the problem of dilution from there on, and the problem that will arise if other people do the same thing all the way down the stream."

You will, I believe, have to apply criteria that will say to you: "This material which you have cannot be dumped into the stream in any more than such and such a maximum concentration, and you will have to clean up your waters as you dump them out of your plant to the point where they achieve this kind of a specification."

This is my view at any rate. This may not now be the practical one, but it will, I believe, come to be the practical one.

This question was asked by Mr. S. C. Martin of the Public Health Service: ***"If 'Safety First' is not the watchword for the safety of the public in the development of new processes and products, what is the watchword for industry?"***

If we had the information to enable us to measure the degree of hazard that is represented in this or that or the other pollutant, we would then be in a fine position to carry out the procedures of preventive medicine and hygiene in relation to water. We do not have this information, nor are we likely to obtain it often until somewhat after the fact. Where we have toxicologic information that says that water to be consumed must not exceed a given level of concentration, we can apply such standards. Where we do not have this information, we'll have to obtain it before we make regulations other than those which are based on judgment. This may have to be snap judgment, rather than substantial judgment, and it will be hard to sustain such judgment in the courts of the land. We must first have the information before we do much about safety first.

Another question: ***"You have mentioned the information available to show the relationship of chemical pollution to public health. Of what significance to public health is the degradation of water sources on the esthetic qualities?"***

This I did not go into, and it is a matter which could justify a discussion in and of itself.

If the water is not satisfactory for use, people will not use it, or will find some way of dealing with it before using it. I perhaps should not say this, coming from the city of Cincinnati in the State of Ohio. But from time to time over the course of the years, we have had so much of the taste of dead algae in the water that even I, who have no fear of the common varieties of dead algae have, in one instance, felt that it was advisable in my own household to get water from another source for drinking. Particularly for making a decent highball. Now, this is an esthetic question, and you can judge as to its importance.

In the final analysis, if the water that you have to drink is unpalatable, you will drink as little of it as possible and this is not good. From this point of view the problem of taste is a highly significant one.

I am also quite certain that official agencies for communities, counties and the like that supply water to the whole community, will not gain the approval of the community if the water that is supplied is unpalatable and, from this point of view, undesirable. We are much more likely to have protests on this basis, and effective protests, than in relation to some insidious poison which does not reveal itself by flavor.

The esthetics of the situation are important, and may well be considered from the point of view of public health in relation to recreation. We will not use our recreational waters if it is not pleasant to do so. This is not good for the community and is not good for the health of the people.

**Dr. TEAGUE.** This question is from Mr. Dappert of the New York Water Pollution Control Board: ***"Is there any history of virus infection epidemics due to inadequately treated sewage effluent due to inability of existing treatment methods to completely eliminate viruses?"***

The one incident I referred to of the sewage effluent backing up above the water intake was in Delhi, India.

It's difficult to pinpoint some of the enteric virus infections as to their actual cause, because some of these diseases are so endemic, so ubiquitous in nature that most of us are getting affected from time to time with these viruses.

But when massive doses of virus are obtained, you usually have enough clinical occurrences. The attack rate being low in these types of diseases, the number of cases is in direct relationship to the number of persons infected. It is only when you get large quantities of the virus taken into a large group of people that you get enough clinical cases to pinpoint the source.

In Kentucky right now we have two epidemics of infectious hepatitis in rural schools. In both instances, it was coincident that the chlorinator on the water supply was not working. I hesitate to imply that chlorination here is the answer to virus infection. We know that the enteric virus infection such as poliomyelitis (all three types of the disease) and infectious hepatitis (which is probably a virus) do seem to be transmitted predominantly through water.

In line with that I'll read another question that came from Mr. Manganelli of Rutgers, New Jersey, relating to the incidence of infectious hepatitis in the United States, its casual relationship to polluted water and disease in the country, with the possible mode of destruction of the virus with chlorine.

This is probably the most widespread infectious disease in the United States today—infectious hepatitis. The number of cases has been going up each year in the last ten years. In Kentucky, my own State, we had about 3,000 cases of definite clinical infectious hepatitis this year, and I am sure we must have had hundreds of thousands of infections because the attack rate is quite low in infection.

In Kentucky, there have been approximately 200,000 septic tanks built in suburban areas. Many of these septic tanks which are used for waste disposal in the suburbs are running over presenting a hazard to children playing in these areas. We believe that the waste disposal methods that have developed around these massive suburban sprawls are contributing to the transmission of infectious hepatitis in many parts of the country.

We are sure too that the transmission of the infection of poliomyelitis still exists in most of our communities. Whether chlorine will kill it in the amounts we use, one and a half parts per million, is somewhat questioned by many people.

The researchers at the Robert A. Taft Sanitary Engineering Center are doing studies on the various viruses. Their results indicate that chlorine will kill them in high enough concentrations, but in the amount used in sewage treatment and water treatment plants there is some question whether all the viruses are killed.

We do know the adeno-pharyngeal-conjunctival virus can be transmitted in chlorinated swimming pools water. Epidemics of this have occurred.

Question: ***"Does not the National Academy of Sciences collect fairly complete information on the toxic and health effects of particular end-use substances?"***

They collect this data. There are a number of other Federal agencies that collect this data. The Department of Agriculture has considerable information, also the Bureau of Standards, the National Academy of Sciences, the Public Health Service. My suggestion was that the Public Health Service take the leadership and try to pull it all together and to determine the void spots and single them out so that research can be done to help the practical public health administrators.

We know substances are in the water but we're not always sure what they are or what they do, and we hope some Federal agency would take the leadership in pooling this information for the benefit of all of us in the field.

**Mr. SCHAD.** This question was asked by Mr. Duke E. Reed of the Forest Reserve District in Cook County, Illinois: ***"If dilution is the proper way to solve the effluent problem, why should Illinois River towns object to Chicago's request for diversion of more lake water?"***

I'll have to plead ignorance. I didn't know that Illinois River towns were objecting to this diversion. There are some possible reasons they might not want more water flowing down such as because it impedes navigation to have more water in the river, but in general this thing looks pretty black-and-white here in Washington. I thought that the State of Illinois wants this diversion, and other States don't, and I didn't realize there was a difference of opinion in the State.

I would like to comment this way: I don't want to leave the wrong impression that I said dilution is the proper way to solve the effluent problem. I'd like to just say that under the present status of our knowledge, we need a combination of treatment and dilution to give us the most economical handling of our waste disposal problem.

Now, there is another question on the Great Lakes situation addressed to Mr. Metzler which I will answer. Then, if he wants to comment further, he can.

This question is from Mr. Bayly of Carlton University, Canada: ***"Is it possible to work out an agreement regarding pollution on international waterways, particularly the Great Lakes system?"***

I would say, of course, that it is possible. It takes a lot more work, just as it takes a lot more work to get an agreement covering waterways affecting two States than it does to solve an intrastate problem. I think there is a mechanism for attempting the solution of these difficult problems involving international waterways by the use of the International Joint Commission. I would hesitate to predict how long it will take them. These things take years. But I don't think we can say that it's impossible just because it's complicated.

I think it's complicated because Canada is at a different stage of development than we are. They may not be as much concerned with pollution right now, but they will be. And as the examples come home to them, they will be more and more willing to participate and share the costs of whatever is needed to handle pollution abatement on the Great Lakes.

I would like to say also that in such things as complicated as pollution in the Great Lakes we need more information, and I for one am very much heartened by the fact that the Public Health Service is now undertaking a major study of pollution in Lake Michigan and the possible effects of a diversion into the Illinois River. We need this information before we can decide what to do.

This question is asked by Mr. F. J. Coughlin of the Association of Soap and Glycerine Producers: ***"Is not the basic solution to ground water pollution, which was referred to earlier in a statement from the floor, the installation of community sewers and sewage treatment to protect the ground water? Or should we depend on community water treatment plants to assure that adequate water quality is available?"***

Well, I think the basic solution is community sewage treatment and sewer installation. For economic reasons we frequently may extend water mains when we don't have sewers, or we may just build subdivisions without sewers because of the cost. But I think it's very shortsighted, particularly since we don't know the effects of all of these residual chemicals such as the detergents which are cumulative. It may take decades for their effects to be known, and in the meantime, with the ground water movement as slow as it is at some places, there will be a building up of a pollutant in ground waters if something is not done about it.

So I think the answer certainly is we should consider installation of community sewers and sewage treatment as soon as we build subdivisions or extend our cities. We have to or else we're just leaving a problem to our descendants.

This question was asked by Mr. Donald D. Kingsley, chief sanitary engineer of Walsh Engineers, Inc.: ***"Stream pollution classification is frequently vague as established by many States and too often is influenced by vested interests. Can it not be within the scope of the Public Health Service to define criteria for stream pollution classifications on a national level?"***

I would answer that my hope is that as we gain more information this will become one of the primary roles of the Federal Government, that is, helping to establish standards, particularly with respect to interstate streams. Right now, in my opinion, we don't have enough information to establish adequate standards.

Now, Mr. Metzler has also asked a question that I'd like to discuss in the same context. His question is: ***"With respect to the necessity of storing water to supplement stream flows for dilution of treated wastes, what role do you see the States taking in such a program? Will they buy space in Federal reservoirs as provided in the Water Supply Act of 1958, or perhaps will they construct their own facilities for supplemental storage?"***

I think that the proper division of responsibility for the water pollution control problem between Federal and local interests is a very important question that is going to have to be resolved. As I see it, water pollution control is about in the same stage now as possibly the function of flood control was 25 years ago before the 1936 Flood Control Act was passed. We're just getting into something that is going to be more and more important as the years go along and as our country develops.

There will have to be a definition of responsibilities between the States and Federal Government. At the present time, and under our present legislation, I think it is very appropriate for the States—I think the States should be encouraged—to participate through provision of storage in the Federal flood control and reclamation reservoirs, but I think that something more is going to have to be done. I think we will probably need new legislation to set up a program to solve this problem. Such legislation should also go into this matter of standards for pollution on interstate streams and also on the works needed to provide the water for dilution.

**Dr. KEHOE.** This question was asked by Mr. L. C. Burroughs of the Shell Oil Company, New York: ***"You indicated that gasoline in the exhaust of outboard and inboard marine engines is extremely toxic, much more so than the lead. Do you know of any cases of harmful health effects from traces of unburned hydrocarbons in drinking water attributed to this source?"***

First, let me point out that I did not say that gasoline was extremely toxic. It is a very irritating material in the alimentary tract. And the frequent and persistent drinking of water containing enough gasoline so that you can smell it, will result in a very considerable irritation of the alimentary tract, with diarrhea. A little bit more will produce blood diarrhea, and a little bit more yet will result in a serious condition.

What I meant to say was that, because of the small quantity of lead and the overwhelming concentration of gasoline in commercial leaded gasoline, the gasoline will produce a toxic effect long before the lead will do so. I also went on to say that you cannot drink enough gasoline to give you tetraethyl lead poisoning, if you are dealing with a standard type of gasoline, because the acute effects of the ingestion of gasoline will not permit you to continue long enough to swallow enough lead to yield a cumulative effect.

With respect to the question of whether cases of this sort have been seen, I know of none, and I think the likelihood of their occurrence, in connection with streams and larger bodies of water is negligible. But the result which I described above has occurred in connection with the contamination of wells and springs, wells in particular, from a gasoline storage tank that had sprung a leak and had allowed the gasoline to get into the drinking water.

Under these circumstances, several cases are on record in which people, having a source of contaminated water have continued to use it in spite of the distasteful characteristics of gasoline—of water containing enough gasoline to smell. Thus, in this manner, gasoline intoxication has resulted.

This is not likely to happen when drinking water is readily obtainable from some other source, but if a well is the only convenient source of your water and it has gasoline in it, the people in the household may continue to use it, under these circumstances, with ill effects.

This question was asked by Mr. Harold L. Jacobs of the Delaware Water Pollution Commission: ***"What is the likelihood that the so-called exotic chemicals which are not subject to biological decomposition—that is to say, in the stream—will be affected by the body processes?"***

I cannot cite off-hand a specific example of this sort of thing, but it could be—I think it may well be—that a material, a chemical, which is not decomposed within a stream, may be dealt with metabolically in the body in a relatively satisfactory manner. I can think of a situation, for example, in which a small quantity of cyanide may occur in drinking water. (This just occurs to me in thinking over the possibility of an example.) Sufficiently small quantities of cyanide in the body are comparatively harmless, because they are converted to thiocyanate and are excreted as such, this being much less toxic.

## PANEL I, Afternoon Session

**Hon. Thomas A. McCann, *Presiding***

The first speaker this afternoon will be Seth Gordon of California, who is well known to many of us here today.

# Impacts of Pollution on Fish and Wildlife, Recreation, and Esthetic Values

SETH GORDON
*Conservation Consultant*
*California State Department of Fish and Game*

I have long been proud to be among that vast army of vocal conservationists who hold that water pollution control must be approached from the broad concept that *our public waters, both inland and coastal, must be kept fit for all human uses and enjoyment* and not offend the esthetic senses of civilized people.

To prove my point, I shall present some background which led to the present status of the pollution control program.

### Shiras the Unsung Pioneer

Leaders of public thought, especially conservationists, early in this century sought to arouse public opinion on the effects of water pollution and their broad long-term implications. The medical profession was concerned chiefly with water borne disease.

Among those concerned with the broader implications was the late George Shiras 3d, a conservationist Congressman from western Pennsylvania. He introduced the first bill to have the Federal Government assume definite responsibility for the elimination of pollution from interstate waters. Mr. Shiras died the recognized pioneer in wildlife flashlight photography—*not* as the pioneer in Congress to initiate Federal water pollution control.

Little was done about the problem, however, in an organized way until the National Conference on Outdoor Recreation was organized by

President Coolidge in 1924 and functioned over a 4-year period under direction of a committee of Cabinet members who asked the Izaak Walton League of America to undertake the task of surveying pollution in the Nation's inland waters.

### Results of Survey Startling

The results of that first survey were startling. They were reported in the May 1927 issue of Outdoor America, the league's official publication. Basic concepts underlying the survey are revealed in this one-sentence quote:

"A civilized community is morally bound to take care of its wastes in a decent and sanitary manner, and not throw its filth out the back door to incubate and spread disease."

The survey established that 85 percent of the Nation's inland waters were polluted, and that only 31 percent of the urban population of the United States then lived in sewered communities which boasted facilities, many of them very inadequate, for the treatment of their wastes.

A few months after the survey was made public, Vice President Charles G. Dawes, in a Nationwide broadcast, commented:

"The fresh waters of Young America are defiled beyond those of any other nation in the world whose civilization and development are comparable to our own. * * * Our problem is to purify our lakes and streams, *not only for the contribution that clean streams make to the health and recreation of our people*, but also for the economic value of the aquatic life they ought to support."

That organized campaign, launched some 35 years ago, and pursued unceasingly, brought about the Federal Government's current responsibilities in connection with the pollution menace.

The Federal Water Pollution Control Act specifies the development of comprehensive programs with due regard given to improvements which are necessary to conserve waters for public water supplies, propagation of fish and aquatic life and wildlife, recreational purposes, and agricultural, industrial and other legitimate uses.

### We Are Still Far Behind

How much better off are we today? How much progress have we made?

According to recent Public Health Service reports, 21.5 percent of the 102 million people living in communities served by sewers still discharge their raw sewage into public waters. Nearly 2,900 new plants are required for the treatment of this raw sewage. Some 3,000 other communities need replacement or enlarged facilities to meet their obligations to downstream neighbors.

Industrial waste treatment construction also is still woefully short of current needs. Even the needs themselves are not accurately indexed. Roughly, an additional 6,000 industrial waste treatment projects should be in operation right now.

Since the turn of the century, the volume of municipal wastes discharged into our watercourses has more than tripled and the volume of industrial pollution is said to be ten times greater.

Obviously, these are some of the things Congressman Hull, of Missouri, had in mind last year when he told a convention of the National Wildlife Federation that:

"As the result of accumulated misuses of our water resources * * * *we are faced today with a monumental water problem* * * * *which if not attacked aggressively today will overwhelm us tomorrow.* * * * *Polluted water can kill people, and it can kill industry.*"

### Pollution—an Ugly, Creeping Menace

Recent widespread usage of new chemicals and synthetics, including insecticides and herbicides, has dramatically changed the character of the Nation's wastes. Known methods of waste treatment won't remove these and other new organics being spewed into our watercourses. Some of them have been traced downstream from distances as great as 1,000 miles. Just how harmful are they? What can we do about them?

Someone has wisely said that this type of "pollution is an ugly, creeping menace which does not make itself immediately evident." An unsuspecting public does not see it, and is therefore unaware of what is happening.

Biological changes resulting from pollution are like creeping paralysis. They may be a long time developing. But once a stream or other surface water dies, an equally long time may be required to restore the natural usefulness, productivity, and beauty of it, even after rehabilitation gets underway.

### Things the Public Does Know

The scope of this paper does not permit a state-by-state review of pollution's known impact on fish and wildlife, recreation, and esthetic values; the total miles of stream and acres of lakes, ponds and impoundments that have become sterile or badly impaired; the large areas in our bays that have become unproductive for aquatic resourses; the miles upon miles of public beaches that have been closed to recreational uses.

But the public is fully aware of the effects of certain kinds of pollution, both industrial and municipal, where these have caused dramatic kills of fish and other marine resources. They are deeply conscious of the fact that health agencies have closed many public beaches, prohibited swimming and other skin-contact sports, and forbidden the use of oyster, clams, and other foods taken from polluted areas.

### A Few Typical Examples

Let's cite a few examples of what has happened to fish and wildlife, including aquatic resources not commonly classed as either.

On the Atlantic Coast there are many: Oyster harvest from certain polluted waters has long been prohibited. In many badly polluted beds the oysters have actually disappeared.

Other commercial fisheries as well as sport fishing have likewise suffered severe setbacks at numerous points along the Atlantic Coast.

Many hundreds of miles of fishing streams in the East were rendered worthless by combined municipal and industrial pollution. The latter includes acid water from hundreds of abandoned coal mines and culm banks, some of which have been remedied, but not enough.

And I suggest you take a look at what has happened to the production of aquatic resources right here on the Potomac. More of that later.

### Waterfowl Suffered Too

A serious decline of the Atlantic Coast brant population some years ago was directly attributed to pollution. In large areas normally covered with eel grass, staple item in the brant's diet, this food was found to have been wiped out by pollution.

During the big duck decline of the mid-Thirties the diving ducks, especially the canvasbacks and redheads, became alarmingly scarce. Unfavorable breeding ground conditions plus destruction of their favorite feeding grounds by pollution caused the decline—not overshooting.

These two favored species of the duck hunter are again in trouble. No shooting of canvasbacks and redheads is allowed this year. How much of the present decline is chargeable to polluted waters on winter feeding grounds?

### The Great Lakes Fisheries Fiasco

Improved fishing gear and unrestrained competitive commercial fishing over a long period of years were credited for the Great Lakes fisheries failure. Lately the lamprey eels have been blamed. Despite an all-out effort to avert disaster, we still are losing the battle.

Would we be better off today if, 35 years ago, all concerned had taken the advice of the late Dr. Henry Baldwin Ward? He recommended a simple two-pronged approach: one concerned regulatory measures; the other, more important, was that the nursery grounds, nature's own fish factories, be rehabilitated by eliminating domestic and industrial wastes.

There have been heavy losses of waterfowl to pollution on the Great Lakes and their connecting waters. One occurred last December when some 10,000 ducks—mostly the scarce canvasbacks and redheads—

were destroyed on the Detroit River by the release of untreated sewage.

### Mid-Continent Troubles

In the great Midwest, hundreds of miles of some of America's beautiful streams are still so badly polluted that fish productivity is far below its potential and phenol taste has ruined market outlets. Recreational values in general have been ruined or badly impaired.

Both commercial and sport fishing have suffered numerous setbacks along the entire Gulf Coast from pollution. Various areas have been declared off-limits to the oystermen because the bivalves were dangerous and unfit for food.

In the Intermountain Region many miles of choice fishing waters have suffered heavy losses from pollution, both municipal and industrial. Often implicated here are flows from both operating and abandoned mines and mine tailings dumps. Many of the latter are most costly to correct and frequently the owners cannot be located.

In the same region the Bear River National Waterfowl Refuge is not producing its maximum. The 500-mile-long interstate stream, for which the refuge is named, is badly polluted. This river could produce wonderful fishing its entire length if cleaned up.

### Far West Has Many Problems

In the Far West, pollution's impact on fish and wildlife, aquatic resources, recreation and esthetic values has presented some unique problems. It has been most difficult to maintain salmon and steelhead runs in streams there. There anadromous fishes are of vast importance to both commercial and sport fishermen, as well as the many businesses of the region which depend solely upon them.

Salmon and steelhead must surmount high dams, rapids, and other obstacles to reach their freshwater spawning grounds. But worst of all is the fact that some of the major streams are so badly polluted in their lower reaches that the fish are blocked in their migration.

Experimentally, in California, young salmon raised in a big Federal hatchery are being hauled overland to brackish waters to bypass the dangers of known polluted areas.

### Abandoned Mines Among the Hazards

Some of the western salmon and steelhead streams have the same abandoned mine and mine tailings dump drainage problems mentioned earlier. They also are bedeviled by large gravel dredging operations which not only destroy salmon spawning riffles and beds but also cover the eggs downstream with silt.

Periodically these sources of pollution destroy many thousands—yes, millions—of young salmon, steelhead, and other fish, both sport and commercial.

Thirty years ago (August 1930), Dr. W. A. Clemens, director of Canada's Pacific Biological Station, discussed problems inherent in the conservation of the famous sockeye salmon runs of the Pacific Coast. Naming pollution and high dams as the two greatest obstacles, he said this with reference to pollution:

"The pouring into the water of substances injurious to plants and animals is inexcusable. In this age of science there should not be a single problem of industrial waste incapable of being satisfactorily and economically solved."

Dr. Clemens' contention has been proved correct in many of the situations in the West. But science *and the willingness to apply it* still lag in eliminating pollution. Annual losses to the commercial and sport fishing industry continue to run into the millions of dollars.

### Native Oysters Gone, Too

The Pacific Coast no longer sustains its native oyster fishery. It was practically wiped out by pollution more than a quarter-century ago.

Today, thousands of cases of seed oysters, from parent stock far less desirable in flavor and quality, are imported each year from Japan to sustain the industry. Since these exotics do not reproduce in West Coast waters, the industry is being maintained as an annual put-and-take program, an enormously costly process.

The bays, estuaries and lagoons along the Pacific Coast play a tremendously important role in the production and maintenance of both commercial and sport fishes, and the aquatic food supply upon which the fishes depend. But many of these waters have deteriorated badly through pollution.

San Francisco Bay, for example, the scene of large occasional fish kills by careless industrial operators, is still badly befouled by pollution, including large volumes from Federal installations. The production of aquatic resources there is far below its potential. Public health authorities must issue annual warnings against eating any of the clams which reproduce abundantly in the South Bay. Swimming and other skin-contact sports are forbidden.

### Is Salt Water Suitable for Dumping Wastes?

Along the beautiful southern California Coast, several large metropolitan areas pour enormously large volumes of sewage and industrial wastes into the Pacific. They are given primary treatment only, then are widely dispersed through expensive diffusers.

These large outflows are believed to be seriously impairing the reproduction of both commercial and sport fishes, and the food organisms upon which they feed.

Studies are underway to determine how far-reaching the effects of these wastes actually are on fish life. We do know, and the public is well aware, that large recreational areas around these outfalls have been closed to swimming and other skin-contact sports.

I predict that very soon public demand will compel the operators of all such sewerage systems on the Atlantic, the Pacific and the Gulf, to install secondary treatment plants.

Long outmoded is the contention that unlimited volumes of partially treated wastes can be dumped indefinitely into salt water with safety.

While losses of wildlife from pollution have occurred sporadically throughout the West, such losses have not been extensive in recent years. The worst killer is still botuliam, which occasionally destroys large numbers of ducks and other fowl, due to inadequate water level controls.

To conclude this phase of my report to this Conference, let me cite the fact that the *U.S. Fish and Wildlife Service reports that nationally, the area of fish and wildlife habitat rendered unproductive each year by pollution is greater than that created by all public agencies conducting fish and wildlife restoration programs.*

## Recreation is Big Business

Leisure-time activities in America, often grouped under the designation of recreation, according to LIFE magazine, are now responsible for an annual outlay of $40 billion, or more than 8 percent of the gross national production.

Much of this large outlay is water-oriented. Included are swimming, fishing, hunting, boating, water skiing, skin-diving, and many other activities.

So important has recreation become in our daily lives that the Congress has set up a special commission to make a national inventory of recreational facilities and future needs. The States of California and New York have recently completed such studies of their own.

## How Many People Are Involved?

Now let's take a look at the numbers of people involved in this recreational program.

More than 32 million Americans purchased hunting and fishing licenses last year. Additional millions, mostly youngsters, pursue these sports but are license-exempt. The Nation's fishermen and hunters spent an estimated $3.5 billion. By 1980 it is predicted that 60 million persons will be buying such licenses, and they will pour $6.3 billion into our economic stream.

In 1959 there were 81 million recreational visits to our national forests, 90 million in 1960. By 1976 it is estimated such visits will be in the neighborhood of 250 million; by the year 2000, about 653 million.

Pressures on our national and state parks and other public lands have skyrocketed in the same startling manner. The National Parks alone had 67 million visitors in 1960. The U.S. Bureau of Land Management, which manages almost 500 million acres of public domain, in its PROJECT TWENTY-TWELVE, predicts that recreational visits to national parks and forests, state parks, and public domain lands will jump from 400 million in 1960 to 1.75 billion by the year 2012.

### Eight Million Pleasure Boats

In 1947 we had 2,440,000 pleasure boats in use on our rivers, lakes and coastal waters. Ten years later it was over 7 million, and today it is estimated to be 8 million. In 1959 recreational boating was a $2 billion industry, almost three times its size of eight years earlier.

Skin-diving, a sport which developed since World War II, has soared into a $100 million business.

These are but a few of the recreational pressures which are dependent upon clean water to survive and prosper. Additional millions of Americans enjoy picnicking, beachcombing, bird-watching, and otherwise relaxing along our streams, lakes and ocean fronts. To them esthetic values are paramount! Who among us would want them to do their picnicking, etc., by the edge of unsightly, polluted waters.

### A Few of the Impacts on Recreation

The foundation of the country's outdoor recreation industry is primarily clean water in our rivers, lakes and the ocean front. Water pollution has the effect of crowding more and more people seeking recreation into less and less space.

Last year a New York City newspaper reported that only 36 miles of the city's 400 miles of waterfront were still fit for swimming.

On San Francisco Bay two additional important beaches were added to the long list of California's waterfront areas closed to public recreation uses.

Narragansett Bay, long the playground of New Englanders, was invaded by algae induced by cesspool seepage.

Along the shores of the Great Lakes pollution is increasing faster than are efforts to control it. Milwaukee, one of the pioneers in city sewage treatment works, was forced last year to close seven beaches because of pollution in Lake Michigan. And Cleveland is losing its fight to keep beaches open for swimming along Lake Erie. Buffalo gave up long ago!

### Washington's River Getting Worse

Sampling of water in the fall of 1960 at Great Falls, Md., showed that the Potomac River was *more polluted than at any time in the past decade.* No one will deny that we have made an open cesspool of George Washington's river, and that great recreational and esthetic values have been needlessly sacrificed right here at the Nation's Capital.

On the Oregon Coast obnoxious odors and foamy liquid wastes turn tourists away from Newport Beach. Raw sewage flows onto the beach through an open stream, and wastes from a nearby paper mill are piped only 1,400 feet offshore.

Some months ago the Speaker of the House headed a delegation appearing before a Congressional committee to urge appropriations to help stop salt water from oil wells from downgrading the famous Lake Texoma, on the Texas-Oklahoma line, because "needed factories refuse to come into the neighborhood" due to lack of desirable recreational opportunities.

Our Nation's recreational facilities are woefully inadequate now. What will they be 40 years hence, unless we clean up our polluted waters without further delay?

## We Need New Philosophies

The foregoing examples of pollution's impact on fish, wildlife, recreation and esthetic values should convince the most skeptical that we need some new philosophies, some bold, new approaches.

Immediately there are those who will say, "yes, but what?"

1. First and foremost, the current philosophy of how much pollution can we add to our waters without public rebellion must be replaced with one of pollution removal and stream enhancement.

2. Those who are legally and technically responsible for cleaning up the pollution mess must join hands with the conservationists. Though their approaches may differ, both are working for the same objective—clean water.

3. Some states set maximum pollution loads for municipalities or new industries seeking approval for new waste outlets. In such situations are we allowing an ample cushion to accommodate future users of the same watercourse?

4. Sanitary engineers have been most efficient, but their training should be broadened to recognize social values. All water pollution elimination programs should include biologists, and probably recreation specialists as part of the working team.

5. The drive to stop publicly-owned institutions and other installations from polluting our waters should be given top priority. President Eisenhower showed the way last spring with reference to Federal installations. Isn't it time that our Governors and Mayors do likewise?

6. Why are we so slow in complying with repeated recommendations from conservation and other organizations that we stop dumping atomic wastes into our streams and ocean waters?

7. Finally, we must *aim much higher* in all of our pollution control efforts. Informed people are saying that water pollution is much bigger and much more important to this country than its present administrative level in the Public Health Service indicates. If this be true, and I believe it is, *isn't it time we do something about it?*

And what is true of our inadequate Federal effort is equally true at the State level.

We must aim much higher if we are to win the battle for clean waters. We must be much more aggressive if we would avoid a water crisis in America. Complacency won't get the job done!

**Mr. GREGG.** Mr. Chairman, Ladies and Gentlemen, fellow members of the Panel: I would like to take advantage of a point of personal privilege to tell you how proud I am that Seth Gordon was once Conservation Director of the Izaak Walton League about 30 years ago and to have the record of this Conference reflect that every American lives a little bit richer life for the contribution that he has made to making our recreation opportunities a little better.

In pondering how we might discuss Mr. Gordon's paper on impacts of pollution on fish, wildlife, recreation, and esthetic values, we thought perhaps it might be useful to see if we couldn't get you some opinions from the people who use the value. Specifically we thought it might be helpful if we would contact our own people, the men and women who belong to our organization, who are active outdoor enthusiasts, and to ask them what effect water pollution has on their own specific recreation habits, hoping that by developing some information on this we might be able to apply it statistically at least a little bit and give us a fresh perspective on the impacts in terms of people.

## DISCUSSION

FRANK GREGG

***Executive Director***
***Izaak Walton League of America, Inc.***

What effect does pollution have on the recreational habits of the American people? At what point in the water quality scale does the recreation user—the angler, the boater, the waterfowl hunter, the swimmer, and all who respond to the elemental appeal of water in their individual ways—decide that a particular section of lake or stream or bay no longer serves his need?

A clear answer to these and related questions would provide both basis and incentive for establishing pollution policy and programs that would protect and enhance recreation values. But the possibility of translating subjective judgments into water quality criteria is remote. Precisely because the judgments are personal, however, the opinions of the recreational water user himself are important—the recreational value of our waters is *determined* by the decisions of people to use, or not to use, them.

This paper will summarize responses to a survey on water recreation and pollution conducted among chapters of The Izaak Walton League of America, a national conservation organization of outdoor-minded men and women. The survey is not represented as definitive. But the responses are so close in important respects to recreation habits of the average outdoorsman as reported in the 1955 "National Survey of Fishing and Hunting", published by the United States Fish and Wildlife Service, that we may claim them to be worthy of consideration.

The responses indicate that at the present time 6 out of 10 of our people have what they consider at least "adequate" water recreation opportunity. But 4 out of 10 do not. And the responses point unmistakably toward a threat of future recreational famine for additional millions; toward an opportunity to double the capacity of our waters to meet future recreational needs by cleansing them of pollution; and toward the need for high goals and vigorous programs, if the threat is to be avoided and the opportunity realized.

The questionnaire was mailed to chapter presidents about October 10, 1960. Chapters were asked to arrive at a consensus among their members on these matters of judgment and opinion:

The member's personal opinion of the quality of his local water recreation opportunities; his use of these local opportunities; his use of more distant waters; his opinion of the capacity of local waters to meet future needs; whether gross pollution of local waters sharply reduces their attractiveness to him or renders them unfit for his recreation; and to what extent he thinks he might use his local waters for recreation if they were unpolluted.

The response to the questionnaire has been satisfactory. Over 190 chapters out of 580 reported in time to be represented in this paper. Reports that appeared not to reflect a consensus, or to be in error for other reasons, were discarded. The following comments are based on an analysis of questionnaires from 159 representative communities across the country:

The first question asked the chapter members to appraise local water recreation opportunities within a one-half-hour drive of the respondents' homes. Thirty chapters reported "excellent"; 62 "adequate"; and 67 "inadequate." These appraisals are consistent with answers given to subsequent questions.

Chapters with "inadequate" local opportunities reported they had to drive an average of 2½ hours (one way) to reach what they consider "adequate" opportunities—perhaps indicating that the 1-day outing is available to considerable numbers only by stretching the hours of daylight.

The answers to questions on frequency of use appear to be significant. Those with "excellent" local opportunities use those resources 21 trips a year on the average, compared to just over 12 for the "adequate," and 11 for the "inadequate" groups. Perhaps more important, chapter members with "excellent" local sport take their families with them 11 times per year, compared to seven family trips in "adequate," and six in "inadequate" areas.

Somewhat surprisingly, the absence of excellent local opportunity may not inspire many more trips to distant points. The question on frequency of use of waters outside the locality brought answers of 2.9 trips per year for "excellent" and 3.6 for "adequate" and "inadequate". All three take the family about three-fourths of the time, with the "inadequates" averaging slightly higher than the other two groups.

We may speculate that a certain minimum quality of sport must be available to maintain the outdoorsman's interest, or to justify his investment in tackle, boats, motors and related equipment. Perhaps as local opportunities are lost to competing recreational uses and urbanization—and pollution—the outdoorsman puts away his rod and gun and turns to whatever alternate pursuits are available. If so, we may say with finality that all of society is the loser for this loss of contact with the outdoors, especially since the loss may extend—through lack of an introduction—to succeeding generations.

The reporting chapters' opinions on future recreation opportunities are consistent with other replies. Those in "excellent" areas reported their waters capable of sustaining half again as much use in 19 out of 24 cases. Thirteen said their local resources could take twice or more the present use. Several noted that use could be multiplied if it were evenly spread through the week, and, to a lesser extent, through the year. But of the "adequate" areas, less than half think a pressure half again as great can be absorbed; only 5 out of 41 see hope for meeting doubled pressures. And 40 percent of the respondents, as previously noted, reported that their local opportunities are inadequate today.

There is clearly a relationship in the areas reported on between pollution and adequacy of opportunity. Sixty percent of the "excellent" and "adequate" areas reported periodic pollution severe enough to effect recreation. The waters involved were reported as polluted about two-thirds of the recreation season. Ninety percent of the "inadequate" areas reported significant pollution present over 80 percent of the local water recreation season.

Pollution sources were remarkably evenly divided among municipal (54), industrial (46), and siltation (56).

Pollution so severe as to simply render the affected areas unsuitable for recreation were reported in approximately the same proportions as less severe pollution. Chapters in the "excellent" group reported 13 instances of severe stream pollution and 4 in lakes; "adequate" areas reported 31 in streams and 9 in lakes; "inadequate" areas reported 41 in streams and 13 in lakes.

The loss of waters for recreation reported by this sample amounted to 85 cases of stream pollution totaling 4,308 miles of stream, and 26 cases of lake pollution totaling 14,519 acres.

A key survey item—perhaps the heart of the entire question of impacts of water pollution on fish, wildlife, recreation and esthetic values—is in the question asking for a consensus on the number of times per year members of reporting chapters would use the presently polluted local water resources, if they were restored to and maintained in usable condition.

The replies are revealing. The "excellent" group indicates that they would use the relatively small proportion of polluted local waters—if cleaned up—about 8 times per year. The "adequate" group, predictably, says 10 times per year. And the "inadequate" group—with unmistakable yearning—estimates its use at 17.8 times per year, if its waters were cleansed of pollution. (The estimate of use appears to be valid; note that the "excellent" group reported it uses its close-to-home waters 21 times per year.)

### Analysis

It is tempting to apply the implication of this modest survey of outdoorsmen to available statistics on numbers of fishermen, waterfowl hunters, boaters, and other assorted recreationists. We will yield to it briefly.

Information from state game and fish agencies shows that a half million fishing licenses were sold in 42 counties reported on in the survey as having adequate or inadequate opportunity. Using the reported estimates of use if polluted local waters were cleaned up (10 more trips per year in adequate areas in 18 in inadequate areas), we find that almost 7 million (6,836,356) man-days of recreation are lost annually in these counties to polluted waters.

A projection of survey figures to the entire nation is similarly interesting.

There were 20 million fishing licenses sold in 1959 and a couple of million migratory waterfowl stamps. Boat owners who aren't fishermen or waterfowlers swell the total. So do wives and youngsters along for the ride. So do tens of millions of people, not classified, who seek the water and the water's edge for recreation. But settle for 20 million, the number of fishermen over 12 years of age alone—an unncessarily modest figure, we can agree.

League members reported they would make from 8 to 18 more trips per year locally if their presently polluted lôcal waters were cleaned up. The weighted average for all three groups was 13. Since the average League member takes to the water for recreation about the same number of times as the average fisherman as reported in the 1955 Fish and Wildlife Service survey (17 as compared to 16.4), we may reasonably apply the weighted average of additional trips to the 20 million. Based what appear to be valid responses from the survey, there are something on the order of 260 million fishing trips a year to local waters not taken because of water pollution.

The figure can be added to with similar data on the opportunities for other forms of water recreation lost to pollution. It can be discounted, if anyone wishes to do so, 10 or 20 or 50 percent, for that matter, without changing the conclusion that it forces upon us:

Pollution is presently destroying and diminishing fish and wildlife production and recreation and esthetic values to an extent that makes the ancient alternatives of "fish or progress" as a justification for pollution a palpable distortion of the recreation values of our waters.

What investments in boats and motors and rods and reels and creels and cameras and cottages and gasoline are not made because of hundreds of millions of recreation trips not taken to local waters? What returns in invigorating exercise, restored spirits and plain human happiness are not realized because of water pollution? A new Fish and Wildlife Service survey to be published next year will help answer the question of economic losses. The noneconomic loss is incalculable.

And what of the future?

People in 40 percent of the representative communities covered in the survey report they presently have inadequate water recreation opportunity. A few more than half of the areas are reported as capable of serving half again the present use; less than a third can serve twice as much with the present amount and condition of water. Yet the population grows, and experts emphasize that recreation demand grows far faster than the population—perhaps, we may suggest, precisely because the pressures of the world make recreation a need as well as a want of our people.

## Summary

The survey confirms, with allowance for error but not for fundamental change, the grim picture of the impacts of pollution on our recreational waterways that conservationists have insisted is accurate.

How much would a nationwide clean-up help? The survey indicates that the number of trips per year to local waters would more than double in the 40 percent of communities reported as "inadequate." In presently "adequate" areas their use would go up about 80 percent. And even in presently "excellent" areas the use would increase about 60 percent.

How can the clean-up be accomplished? Not, we contend, by the currently widely advocated notion that wisdom compels us to use our waters to a debatable "maximum" for waste dilution. On the contrary, any such maximum-use-for-waste-disposal philosophy will condemn us to a surface water resource just clean enough not to pose a direct threat to public health but far below the standard necessary to maintain recreation and esthetic values.

More people, more industries, new processes, new pollutants (insecticides and pesticides should be noted) force us to discard the "load it to the hilt" philosophy.

We must, as Seth Gordon has said, adopt a conservation philosophy. The concept of stewardship applied to the problem holds that we must accept the positive policy of keeping our waters as clean as we can to serve the widest range of present uses with the greatest possible margin for future uses—as opposed to the negative policy of keeping them as dirty as we dare.

This Conference can help significantly by:

—recognizing the recreation value of our water resource as a full partner with domestic, industrial and agricultural values in water quality management policies and programs;

—accepting the conservation philosophy of water pollution control, including specifically the necessity for maintaining water of such quality as will meet recreation needs;

—helping those directly responsible for pollution abatement find better ways to tackle their problem; and

—agreeing on programs placing prime responsibility on sources of pollution, but also making full creative use of the delegated powers of government—local, State and Federal—to study, educate, persuade and assist; and, where necessary, to speed action through vigorous enforcement of strong, equitable laws.

## DISCUSSION

### Mrs. E. Lee Ozbirn

***President***
***General Federation of Women's Clubs***

Water pollution has been termed our national housekeeping problem. How I wish that I, a natural-born housekeeper, possessed a magic broom that I might sweep all this pollution out of the streams, rivers, lakes, and waterways that a prodigal nature lavished on our country, and restore them to their pristine purity for all to use and enjoy! But, alas, there is no such magic tool.

Does it not seem incredible that while we were producing push-button appliances, thinking machines, super highways, and all the wonders of our modern technological era, we permitted this insidious menace of pollution to creep and spread so that great numbers of water recreation areas, once our national pride, are now scars on our national conscience?

Even now, while we are planning to visit outer space, we might do well to visit our own front yards and observe the countless water areas in the East and West, North and South, yes, all over the country, which have been removed from public use because they no longer meet the health requirements for water sports, and are posted—"Keep Out—Water Polluted." All too familiar is the threat of our vanishing shoreline for play purposes. Of New York City's 575 miles of coastline only 35 are suitable for swimming.

To fully appreciate the impact of water pollution on recreation and aesthetic values let us briefly consider some facts and figures. At the top of the list is the irrefutable fact that water is a necessary part of recreation for a vast majority of people. *Life Magazine* in a recent survey queried its correspondents all over the country on their leisure time pursuits, and the answers overwhelmingly emphasized water sports—boating, swimming, fishing, water skiing, and skin diving. There is a therapeutic effect which water possesses. It induces a feeling of exhilaration and relaxation, while it restores and re-creates our spiritual and physical self. Such revitalization is important in our hectic modern life in helping us to maintain a healthy equilibrium.

The total number of water recreation enthusiasts must represent an astronomical figure, to judge from some recent statistics. A Gallup poll in 1959 estimated there were 33 million swimmers and 32 million fisherman. The Outboard Boating Association claimed 35 million small boat users. It is a comparatively short time since water skiing became popular in this country, yet according to estimates 6 million now indulge in this sport. Skin diving, another newcomer to water activities, accounts for many millions more. This all adds up to hundreds of millions of recreation hours which depend on water—clean water—and has brought a new word into our vocabulary—aquamania.

I daresay there are many people who would place the economic value of water recreation activities at the top of the list. Certainly of the 40 billion dollars spent annually on leisure time recreation, water sports account for a huge slice. Boating alone contributes some $2 billion, while women bought $225 million worth of bathing suits just last year. Yes, the economic value is mighty important to our Nation's prosperity.

But there is another value of water recreation which is equally important, though it cannot be measured by any statistical yardstick—and that is the intangible, aesthetic value. Who can assess the worth of happy memories we carry through our lives of picnics at the lake, Sunday afternoon drives with the family along the bay, or sitting on the beach relaxing while the children splash around in the water.

Who knows what masterpiece of painting, or poem, or song might be inspired as its potential creator idles along in a canoe on the local Loch Lomond? (Has anyone heard of a poem or song dedicated to the polluted Potomac?) In the lives of millions of families this value in terms of happiness and pleasure is immeasurable and incalculable.

Why has this problem of water pollution and its impact on recreation areas become so demanding of immediate remedial action?

In the span of a single generation in our country the very nature of our water supply, our most precious natural resource, has been greatly altered by the ever-increasing amount of untreated and partially retreated wastes that are being dumped into our rivers, lakes, streams, and coastal waters. This situation got out of control before its magnitude was realized, and we have not been aggressive enough with our treatment programs to catch up, let alone get ahead of this grim condition.

A river or lake lost through pollution to recreational enjoyment requires a very long period of time to restore it to its natural beauty, even after treatment gets underway. Mr. Gordon and Mr. Gregg have given us some impressive figures in support of this. Thus we have created a vicious circle—pollution of our waterways increasing at a faster rate than treatment, which in turn reduces the amount of water recreation areas at the very time that there is an ever increasing demand for such water acreage.

It is this increase in the need for more water recreation areas that points up the urgency of accelerated remedial action. When more people have more leisure time which they devote to recreation, more facilities are demanded, and particularly facilities for outdoor recreation which includes water sports.

We recognize how imperative it is that pollution programs be accelerated to provide for the present needs. What about the future? Must we not at the same time anticipate the demands of the mounting recreation load ahead? Think of the water recreation acreage that will be needed in the next decade, with its estimated increase in population of about 34 million, and the increase in leisure time which will result from the work week which may then be 32 hours? Foresight and vision are demanded of us now if we are not to pass this dilemma on to future generations.

What are we doing to avoid this? Since another panel is concerned with the ways and means, I will not go into specific details, but I cannot stand before you and present a summary of this deplorable situation without expressing my strongly held views on the action I believe should and must be taken.

In the past, it seemed as if pride in one's community would be sufficient to deal with any local pollution problem. This has proven to be unavailing. States alone seemed unable to carry the financial burden of such a gigantic task, and as a result, the Federal Government entered the battle with the Federal Pollution Control Act. It is indeed heartening to find that this Act specifically includes in its provisions the words "recreation purposes." Moreover, in a recent "stop pollution order" issued by Secretary Flemming, and served on Kansas City, Kans., and Kansas City, Mo., and a long list of industrial firms in those cities, the action declared, and I quote, "that this pollution not only hurts the water supply in several cities, but also impedes development of the Missouri River for recreation purposes."

Public consciousness seems to be awakening to the seriousness of the situation, and municipalities, States, and industry here and there, recognizing its criticalness, are taking some remedial action. This is certainly encouraging, but time does not permit this to be done inch by inch—huge strides must be taken. The answer seems apparent to me—we must have legislation and legislation with teeth in it. Just where this should begin remains to be established, but it is our duty as responsible, responsive citizens to press for proper legislation that will make available for recreation purposes all water areas, be it Boggy Creek, in Sentinel, Oklahoma, or the Potomac, in our Nation's Capital.

# Effect of Water Pollution on Industry

LELAND C. BURROUGHS
***Assistant to the Vice President—Manufacturing***
***Shell Oil Company***

All of us use the term "water pollution" as though it were a specific thing capable of precise definition. This is not the case at all. What may be considered pollution by one user of a stream's water may be completely ignored by another. An industrial user who may care nothing about taste and odor can be seriously affected by a small amount of nitrate contamination. The situation would be reversed for a muncipal water works.

Because streams and lakes have the ability to purify themselves they have always been used for disposal of aqueous wastes. Those who use streams for this purpose feel they have a right to this privilege within limits, although selfish interests may cause abuse of this privilege. Beyond question, some industrial plants must be included among those with selfish interests; however, State and Federal laws, and the pressure of public opinion have forced close controls on industry.

There are others less closely controlled. Farmers who sue to collect damages for industrial waste damage to livestock or property may themselves employ poor soil conservation practices, thereby affecting industry downstream. Municipalities have caused industries to lay out large sums for waste treatment in order to protect the city water supply while these municipalities are themselves dumping volumes of sanitary sewage and other wastes into the stream and the citizens are unwilling to correct this pollution although it is causing serious downstream effects. The U.S. Public Health Service is to be commended for its efforts in making the individual citizen aware of his responsibilities in abating stream pollution.

When, then, is a stream polluted? Of course, we recognize that water pollution can be judged in many ways depending upon such things as nature of contaminants, amount of contaminants, ability of the water to purify itself, use of the water, individual opinions as to degree of pollution, etc. Nevertheless, most definitions of water pollution recognize that all natural surface waters have some capacity for assimilating contaminants and that there are sound reasons why this capacity should be, and probably always will be utilized. This is true because stream contamination comes from countless sources including such things as decaying vegetation, silt, natural salt deposits, industries, municipalities, and agriculture. The number of sources is increasing daily as are the problems of control.

As has been said many times, "Pollution becomes a major problem when the assimilative capacity of a stream is exceeded." But this is vague and may be considered as assuming that the water will not be used until it has adequately diluted its waste load or purified itself, which is, of course, unrealistic. With increasing population and industrial activity along streams there will be less and less opportunity for self-purification of streams.

A good definition of pollution seems to be that of Dr. Richard D. Hoak, of Mellon Institute, who has stated "Pollution is the discharge of material that unreasonably impairs the quality of water for maximum beneficial use in the overall public interest." This definition leaves open the question of "What is unreasonable impairment of water quality?—and rightly so as quality needs for various uses can differ widely. For the purposes of this paper, no effort will be made to define pollution within any close limits but rather to speak of it broadly as the discharge of material causing objectionable effects in the receiving waters.

In considering the impact or effect of water pollution on industry let us first discuss the effects on industry of using water from polluted streams or other sources. There are thousands of industrial plants ranging from one room units discharging into city sewers to immense and complicated industrial plants with waste treatment facilities and separate outfalls. These plants are units of many industries including foods, chemicals, steel, automobiles, plastics, mining, petroleum, ceramics, pharmaceuticals, fermentation, distilling, machinery, paper, etc. Water quality and quantity requirements vary between these industries and, in fact, differ broadly between units of a single industry. For instance, two plants of a single chemical company may have vastly different water needs because manufacturing processes are not the same or because different chemicals are produced. A food or beverage company may require water of high purity because it is used in marketed products. On the other hand, a paper company may use water only in the manufacturing process.

While it is not possible in a single presentation to discuss the water quality and quantity requirements of individual industries, certain generalities can be drawn.

1. Industry uses large volumes of water for cooling purposes. This may amount to one-half to two-thirds of the total usage. In many industries such as petroleum, chemical, and power, the water may be taken through closed-pipe coolers and condensers and returned to the lake or stream on a once-through basis. Water quality requirements for such service are modest with the most objectionable pollutants being (a) mud or silt which is erosive and deposits in the cooling water system, (b) corrosive pollutants such as acids and (c) organic matter, particularly slime-forming organisms. Scale-forming compounds (hardness) are objectionable. These constituents as well as bacterial slimes may seriously interfere with heat transfer through cooler or condenser tubes. A number of large industrial plants located near the coast use sea water for once-through cooling purposes even though this water is quite corrosive due to its salt content.

Many industrial plants, both large and small, use spray ponds or towers for removing the heat from process cooling waters and thereby have made it possible to reuse the water many times. There is some loss, due to evaporation in the tower, and withdrawals to the sewer, to maintain a satisfactory level of dissolved solids. These losses and withdrawals are usually replaced with clean water taken from wells or from city water mains. Large refrigerating or air-conditioning units usually have a recirculating type of cooling water system. In some instances, particularly where the water is taken from deep wells, it must be softened before being used for make-up purposes in a recirculating system. This treatment reduces scaling of tubulars.

It may be said that salt is the most objectionable pollutant in industrial cooling water taken from surface water supplies. Where the problem is critical an industrial plant may install sedimentation basins to remove the solids or use wells or other water sources. Although large volumes of water are used, the consumption is small and volumes returned to a stream are closely the same as those withdrawn.

Waters which have been used for cooling purposes through closed systems are rarely the cause of stream pollution. There is, of course, the possibility that the cooling water may increase the temperature of the surface water into which it is discharged, usually by not more than a few degrees. This type of "pollution" has been much discussed and its importance probably greatly exaggerated. It has not been firmly established that water quality is significantly impaired by temperature changes, within limits, particularly when the warmth is contributed by a continuously operating plant such as a power company. The temperature of a stream may vary over a range of say 40° F. from winter to summer and heavy rainfall may change the temperature of a stream a number of degrees in only a few hours.

2. Industry employs water for many process purposes. These include (a) cleaning of products and process equipment, (b) use as a

solvent for chemicals, (c) testing of tanks and process equipment for leakage, (d) hydraulic removal of bark from logs, (e) scrubbing of gases and liquids, etc. In many cases water may be a major part of the product being manufactued. Water quality is critical in some industries simply because it contacts or enters the product. It is estimated that about one-fourth of the water required by industry is used in the manufacturing processes themselves.

The degree of purity needed varies over a broad range but in general reasonably clean and silt-free water is required. River water, even though essentially free of man-made pollution, is seldom suitable for use as process water due to its content of silt and other contaminants. Lake water has limited application. Most industrial process water is taken from wells or treated surface water supplies. It is difficult to generalize as to industries' needs. For example, the food industry must have tasteless water of high purity, the textile industry wants water of low hardness, the paper industry needs water free of turbidity and substances that could color paper, the beer industry must have odorless and tasteless water free of nitrates, bicarbonates, ferrous iron and copper compounds. Chlorides cause difficulty in the steel industry, iron and magnesium are a problem to the producers of plastics. The manufacture of pharmaceutical and biological products requires water purity considerably above drinking water standards. The chemical and oil industries use many separate and distinct manufacturing processes and water quality needs vary accordingly. Many other examples could be cited to show that industry-process water quality requirements are varied indeed and that the natural impurities in the water supply, be it stream or well, may be of greater concern than those caused by the activity of man. Also, regardless of the water source or degree of pollution, treatment may be necessary to prepare water for specific industrial use.

3. It is probable that about 10 percent of the water used by industry goes to boilers for the production of steam. There has been a pronounced trend toward higher and higher boiler pressures and temperatures in recent years. This is necessitating the use of boiler water of exacting quality specifications if corrosion, scaling, and frequent boiler shut-downs are to be avoided. In general, boiler feed water should be reasonably free of dissolved solids, particularly those which are scale-forming or may cause priming. Regardless of source and cleanliness, water for boilers usually requires softening to remove scale-forming compounds.

4. Industry has many non-process uses for water including fire fighting, washing of equipment, special cooling applications such as tanks and pump glands, irrigation, and miscellaneous. Quality needs for these services are not high; however, the water must be free of

silt. Perhaps no more than 2 to 5 percent of the water use is for these purposes.

5. Each industrial plant must have an adequate supply of water for drinking and all sanitary purposes. Usually this water is taken from wells or purchased from a city water company. This supply, because of its purity, is also satisfactory for most industrial applications. However, potable water supplies do not meet the critical needs of many industries until they are subjected to further purification.

All industries use water—some in tremendous amounts. It is significant that in spite of this fact there are only rare and isolated instances where an industrial plant has considered or proposed any sort of limits to control the level of general contamination of its water supply. There are, of course, cases where the waste discharge of a nearby municipality or a neighboring plant has caused a major water quality problem. Such situations, with the source of the objectionable pollution clearly indicated, are usually worked out between the parties involved, with recourse to the courts under existing laws, if necessary. In general, it may be said that units of industry accept their available water supplies with relatively little complaint, and treat or purify them as necessary to meet their individual requirements. The cost of purification of water will vary according to the circumstances but is usually not great as industry's greatest water need, that is for cooling water, does not demand high water quality.

One may not discuss the effect of stream pollution upon industrial use of water taken from the stream without looking at the other side of the coin and considering the effect of this pollution upon the level to which the purity of the return waste water must be raised to avoid objectionable effects. It has already been stated that the vast majority of industrial plants will return to a stream volumes of water nearly as great as those withdrawn. Parts or all of this water will contain potential pollutants originating from process wastes, leaks, and spills. Traditionally, industry has discharged limited amounts of wastes into lakes and streams without objectionable effects. With increasing population and growth of industry most companies have found it necessary to reduce waste discharge to much lower levels in order to maintain satisfactory conditions in the receiving waters. They have been strongly encouraged to do so by social pressure from the local citizens.

One of the first steps normally taken by an industrial plant in its studies to reduce discharge of contaminants is to examine carefully all possible means of lowering the volume of waste water. In so doing, the size of the facilities needed for treating this water for removal of objectionable constituents will be smaller and the cost will be lower. More efficient use of the water taken into the plant has been achieved in many ways, including changes in manufacturing processes, greater reuse of water, a change from cooling with water to cooling with air, careful control of water flows for cooling bearing and pump glands, and others. Reuse of cooling water by circulation to spray ponds or towers results in great reductions in the volume of water discharged from a plant.

It is common knowledge that an electric power plant, using steam turbines for driving the generators, may return to the boilers virtually 100 percent of the water resulting from condensing the steam. Since little make-up water is needed, the problem of treating this fresh water to remove objectionable chemical constituents or pollutants is a minor one.

Many other industrial plants which use steam solely for process and heating purposes also conserve water by reusing steam condensate in boilers. A large oil refinery, for example, uses well water for a particular process requiring year-round cold water for cooling. The warmed water is then used as boiler feed water. The following approximate figures apply at this refinery for winter peak boiler loads.

| | *Gallons per minute* |
|---|---|
| Fresh boiler water | 3, 250 |
| Steam condensate return to boilers | 1, 050 |
| Total | 4, 300 |
| Steam condensate, water treater blowdown, and boiler blowdown to refinery sewers | 3, 200 |

It is of interest to note that one-fourth of the steam production is from steam condensate. Very little water is lost or consumed, as the volume from boiler sources discharged into the refinery sewers is only slightly less than the fresh water to the boilers.

It is disturbing to industry that some municipalities are extremely reluctant to spend the money necessary to provide adequate sewage treatment plants even though this may amount to relatively few dollars per resident. The general attitude seems to be to cause industry to achieve low levels of contaminants in effluent waters, thereby providing more room in streams for untreated or inadequately treated municipal sewage. This attitude persists in some cities even though Federal grants pay a significant percentage of the cost of municipal treatment plants. Industry pays the entire cost of its own facilities and its taxes contribute importantly toward payment for the municipal facilities.

Industrial management, for the most part, does not believe that pollution of industrial water supplies will increase to more critical levels in the near future. In fact, it is virtually impossible to predict with any satisfactory degree of confidence the extent to which an estimated rate of industrial expansion, in combination with normal population growth, would affect stream pollution. Virtually all large industrial plants being built today are including provisions for control of waste water quality. State and municipal regulations demand adequate clean-up of waste waters and many require that detailed plans for treatment of waste waters from new industrial plants or revisions or extensions to existing manufacturing processes or waste treatment facilities be submitted for approval. The citizens of municipalities are becoming increasingly aware that they, as well as industry, must assume financial obligations for control of municipal wastes. Industry is certainly aware of its responsibilities and is spending much money on facilities and research. These efforts are bearing fruit and their continuance is assurance to industry of satisfactory future water supplies.

More and more frequently in recent years, articles by so-called water resources experts have warned that there is a general water shortage and that in 20 years this shortage will be critical to the extent of seriously affecting technological and industrial progress. Such forecasts are usually based on "use" of water by industry and municipalities without proper regard to the fact that water may be used countless times without being lost. In fact, water is not consumed. It can be lost only by evaporation, by soaking into the ground, or by transportation to another location.

It has been said that it takes 2½ gallons of water to make a phonograph record, 5 gallons to process a gallon of milk, 8 gallons to produce a pound of sugar, 150 gallons to make the paper used in a 5-pound Sunday newspaper, and 600,000 gallons to make a ton of synthetic rubber. While these figures may be interesting they have little or no significance, as the water is not evaporated or lost but largely reused or discarded to a stream. Some industrial plants use closed systems in which water is reused countless times, thus conserving water and avoiding the possibility of causing stream pollution.

### Summary

Industry's greatest water use is for cooling. The most objectionable pollutants are silt and organic matter, although corrosive and scale-forming substances can also cause problems. Increased attention to soil conservation practices and other steps to reduce silt loadings of streams would be beneficial.

Continuous recirculation of cooling water to spray ponds and towers is practiced extensively by industry as a means of conserving water. Water for this purpose is usually taken from wells or municipal water supplies. Pollution is not a frequent problem although treatment is sometimes necessary for removal of objectionable constituents.

Industry's water quality needs for process purposes vary over a wide range from such noncritical requirements as the washing of gravel to the exacting qualifications of the pharmaceutical industry. Whether the water source is stream, lake or well some form of treatment by industry is necessary to condition the water for may applications. Boiler feed water must be clean and satisfactorily free of scaling constituents, corrosive substances and organic matter.

Industry must have an adequate supply of water for drinking and sanitary uses. This source of supply is also used by many industries for certain process and cooling purposes. Pollution of this water is rarely a problem to industry.

For the great majority of all industrial water uses municipal and industrial water pollution has not caused problems. Certain applications have necessitated special purification treatment to remove contaminants. Industrial plants usually accept their available water supplies with little complaint and provide treatment as necessary to obtain the required water purity.

Industry believes it has been and is making good progress in abating industrial pollution of surface waters, in developing answers to its waste disposal problems, and in conserving its water supply by improved efficiency and reuse. With a continued industrial program and equal efforts by municipalities and agriculture to reduce water pollution, industry confidently believes that pollution of its water supplies will be less and less of a problem in future years.

## DISCUSSION

K. S. Watson

***Consultant***

***Water Management and Water Control***
***General Electric Company***

Mr. L. C. Burroughs has in his paper adequately covered major water uses in industry and the effect of pollution on these uses. Since this is the case, I will not in this discussion cover the same material but will briefly consider some other related areas which have been called to mind.

Industry is obviously interested and concerned with water pollution control as a result of her ever-expanding water requirements. For industry to make the necessary contributions to the economy for the continuation of national growth and prosperity, adequate water of the proper quality must be available for cooling, process, boiler, sanitary, and miscellaneous purposes.

### Pollution Control

In recent years industry has been more and more motivated by the responsible corporate citizenship concept. Within the scope of this philosophy is the desire to discharge an effluent which does not seriously pollute the receiving stream. In an effort to properly protect the stream, responsible industry as a matter of course designs along with the design of new manufacturing facilities, necessary equipment to control and treat wastes. Plant expansion projects are also being given the same consideration. Controlling pollution from existing plants is more difficult but great progress has also been made in this area.

This brief review of industry's efforts to control plant wastes leads to a slightly different twist to the subject under consideration. It might be worded as follows: "What are the effects of pollution control on industry?"

It is apparent, perhaps, that the major effect that the incorporation of waste control and treatment facilities into manufacturing plants does have is that of increasing industry's investment in its physical plant. The manufacturing plant also becomes more expensive to operate in proportion to how extensive the waste control facilities may be. All this, of course, adds up to the fact that it becomes more expensive for industry to carry on business. In the final analysis, therefore, industrial products must be increased in price to the extent necessary to cover these additional costs.

## New Plants

Industry must obviously consider many factors in deciding upon the location of a new plant. Two of the considerations which have been growing in importance in recent years are: the obtaining of a sound source of water, and finding a location with a satisfactory waste control climate.

The magnitude of stream pollution is often significant in an industry's consideration of whether the water situation for an area is sound for a plant-developed supply. In some cases, however, the natural characteristics of the stream or well water could be such that this would preclude certain types of industries choosing the area for a plant location, regardless of pollution considerations. If the industry is interested in obtaining part or all of its water from the municipal supply, it will have to satisfy itself that a sound and equitable agreement can be reached with the city in question.

Many factors come into the evaluation of the waste control climate. A major one is whether the assimilative capacity of the stream under consideration is such that it can accept the treated discharge from a new plant in addition to the loads being contributed by existing municipalities and industries. The industry also must be confident that the water pollution control program in the State where the plant is being located is in competent hands, and the climate at State and interstate levels is such that a matter as important as pollution control will not be influenced by partisan politics. If the plant desires to connect part or all of its discharge into the city sewer system, an appropriate and equitable agreement must of course be reached with the municipality under consideration.

### Water Legislation

One other effect of water pollution on industry has been to sharpen industry's interest in water resources legislation. The concept that pollution control is primarily a State responsibility is a rather generally held concept so it will not be considered here.

What I would like to briefly consider, however, is what constitutes a proper format for sound water resource legislation at the State level. There has been a trend in recent years toward centralizing all water resource authority in a single State agency. Such a trend can be sound or unsound depending upon the approach used in a particular State.

The classic concept until recently has been for each branch of State government, with an obvious interest in water, to exercise control over that particular interest. . This approach thus verifies the thought that it is not sound to combine all responsibility for water control in a single special interest department.

It would seem that one of two sound procedures can be used by the States to modernize the water legislation structure so it is more in keeping with the requirements of the times:

1. Existing law can be sharpened up so the various water interests can be left in existing departments but duplication of effort reduced to a minimum.

2. A new department of water resources can be created in which all existing areas of interest can be included as divisions.

### Water Treatment

In many respects an industry looks at the treatment of polluted water much in the same manner as does a municipality. The more polluted the water is, the more expensive and costly it becomes to convert it into a satisfactory water supply. In municipal treatment, the concern is to make the water potable and safe for human consumption. In industry there is often not the same degree of concern about safe and potable water because many plants use city water or wells for sanitary requirements.

On the other hand, industry is often concerned with conditioning a portion of its water supply so its mineral content is lower or changed in form. This is most often done by softening, deionization or distillation. Industry's general orientation, therefore, is that if a particular process requires a special type of water, necessary water tailoring equipment will be installed to supply the demand. Industrial representatives will then probably have the tendency to take the view that coping with the stream pollution resulting from the increasing complexities of national life merely becomes another one of the increasing costs of doing business.

**Mr. FOX.** Members of the Panel, Ladies and Gentlemen: When the topic was assigned to me for this paper today it was entitled "Benefits of Clean Water." I'm glad of my foresight this afternoon after hearing the eloquent statements that we have already heard about the benefits of clean water that I did not stick strictly to that topic and chose my own subject.

I am pleased that I am to follow Mr. Burroughs, who indicated, I believe, an important fact here, namely, that there is a question of taking into account both benefits and costs in considering the problem of pollution abatement.

# Pollution: The Problem of Evaluation

IRVING K. FOX
***Resources for the Future, Inc.***

In a quite general way we recognize many benefits from clean water. But as far as I know, we have no basis for measuring these benefits in a systematic manner. The menace to public health is often advanced as the reason for pollution abatement policies, but seldom with any bill of particulars. The most common justification of all seems to spring from a general public reaction against pollution. The word "pollution" connotes evil; therefore it must be opposed. But as the quantity of wastes from cities and industry becomes ever larger with each passing year, as these wastes grow more complex, as more pesticides and other chemicals wash into our streams, and, as a consequence of all these things, the quality of the nation's water resources continues to deteriorate, the need for a much more systematic approach to the analysis of pollution problems becomes essential.

I could recite in general terms the benefits of clean water from the point of view of public health, outdoor recreation, commercial fishing, or the industrial water user. This would add little or nothing to what we already know about the situation. Nor would it stimulate constructive thinking about what has become our major water problem. Accordingly, I believe we can use our time here much more profitably to examine the task of systematically appraising the benefits of clean water.

My premise is that there are limits to the price we will pay for clean water. Only where recognized benefits exceed recognized costs, will it be practicable to institute effective pollution abatement measures. Not until we have a framework for analysis that will provide a relatively precise understanding of benefits and costs, will we have a sound basis for the design of public policies and programs for effective water quality management. We do not have such a framework today and this I believe is one of the reasons that we remain unclear about the kinds of policies which should be adopted to assure appropriate standards of water quality.

One reason that we do not have a suitable framework for the analysis of benefits and costs is that we are dealing with an unusually complex problem. Numerous interrelated factors must be taken into account in the design of an appropriate system. My objective here is twofold: (1) to identify what appears to be some major elements of the problem and (2) to suggest some lines of study which will help us establish a suitable basis for benefit-cost evaluation.

An elementary yet essential first step is to establish a classification of the kinds of water quality deterioration which is useful for purposes of benefit-cost analysis. There are many types of pollution and their effects upon water values vary a great deal. Silt causes one kind of water quality deterioration. Heat from cooling processes causes another. Salts accumulate as a consequence of irrigation. Organics are contributed by cities and many industries. The synthetic organic wastes and the inorganic chemicals contributed by industry pose quite different problems. The sanitary engineers and the biologists recognize these differences in research and abatement activities. Nevertheless, a classification needs to be articulated and data related to it so that such data can be used for evaluation purposes. I'm not qualified to suggest a suitable classification system. The development of such a system will require the coordinated attention of people from several disciplines including the social sciences. Until we have a classification system designed to serve the purposes of evaluation, we cannot evaluate benefits and costs in a systematic manner.

A second essential step is that of defining quite precisely the different kinds of values with which we are concerned in water quality management. An over-simplified concept of benefits and costs must be avoided. Most of us will agree that the benefit-cost ratio—as it has been developed and applied to construction projects—has not been a completely satisfactory measure of water project desirability. Aside from technical deficiencies in the practices for benefit-cost analysis which have been applied by the Federal construction agencies, a major defect has been that evaluation practices have dealt effectively with only one of several sets of values involved in water development, namely those values that can be expressed in dollars. This defect should be avoided in applying a system of benefit-cost analysis to pollution abatement.

A differentiation among values may seem elementary but I submit that much of the difficulty over pollution policy stems from confusion over the values we want to optimize. Pollution of the Potomac is considered "serious" or "critical" but I gather waterborne disease is not evident among the population of the Washington metropolitan region. The story of Chanute, Kans., suggests that organic wastes in sources of municipal water do not constitute a serious health problem. This may be erroneous but it underscores the necessity of defining sharply the justification for abatement measures. If it is for health reasons, what are the dangers and risks, what are the alternate ways of avoiding these dangers and what are the comparative costs? My view is that in addition to public health, other values loom large in the justification of pollution abatement measures.

I suggest that consideration be given to differentiating among at least three kinds of values. These are health values, aesthetic values, and what I will call for lack of a better term, "market" values. Health values and aesthetic values cannot be measured satisfactorily in monetary terms. Yet some measures or indicators of value can, no doubt, be devised by imaginative individuals. Market values are measurable in monetary terms but for a variety of reasons in the case of water quality management they are not subject to optimization through market forces. Therefore, governmental action is necessary. Techniques of analysis in the field of welfare economics can be applied to the assessment of these values.

A third element of the problem of benefit-cost analysis—and by far the most complex and difficult one—is that of taking into account the physical and biological aspects of water quality management. A given stream has a certain regenerative capacity after the effluent has been discharged into it, depending upon the quantity of flow, gradient, temperature, and other factors. Because of the variability of stream flow, this regenerative capacity varies from time to time. Uses differ as to the water quality that can be tolerated. Aquatic life requires a certain quantity of oxygen. Domestic water must meet rigid standards for public health reasons. If water is heated its value for cooling purposes is reduced. These physical and biological aspects involve a large number of interrelated variables which have defied handling in a systematic way to date. To translate various mixtures of effluent, contributed at different locations under varying conditions of stream flow, into costs to downstream users at a series of locations is an unusually complex task. Yet, this is the problem that must be solved if we are to go beyond informed judgment in appraising the values associated with water quality management.

A fourth factor that should be considered in the assessment of water quality values is that of technological change. Technical innovations alter the character of effluents with which we must deal. Also, technology can improve our capability for dealing with the pollution problem. One of the major tasks in evaluating the impact of pollution, or of proposed pollution abatement measures, is that of taking into account the probable effect of technology over time. Values may increase or decline during the life of a given investment as a consequence of technological change. For example, if low cost techniques could be devised for treating organic wastes so that dilution water would not be required to maintain oxygen content, investments in reservoirs for low flow regulation might be of much less value within a few years.

A fifth consideration that a system of evaluation should take into account is the political institutions through which action is achieved. This requires that attention be given to the incidence of benefits and costs. It is a characteristic of the pollution problem that those who contribute the effluent to a stream often do not bear the inconvenience, the monetary costs, or the loss of other values from such pollution. Thus when we speak of a benefit or cost it is important to recognize how these costs and benefits fall, i.e., who will receive the benefits and who will pay the costs. This is not a simple task because both benefits and costs tend to spread out through our society. It is not only the owner of the plant discharging untreated effluent into a stream who benefits from the opportunity to do so with impunity. Those who purchase the product of the plant may pay lower prices than they would if it were not possible to discharge untreated effluent. As a result policies for water quality management will almost certainly have important income redistributive consequences. The extent and nature of such redistribution will help determine what policies and programs can be adopted. A major deficiency of benefit-cost studies for water construction projects has been the general failure to give attention to the income redistribution effects of water development.

It is evident that a given pollution abatement policy or program will benefit some political jurisdictions or interest groups and impose costs on others. Since streams run across state boundaries, the benefit from waste discharge into a stream in one state may result in costs to the states downstream. Also, since pollution abatement measures may impose costs on a water using industry, states and localities will be concerned about the effect of abatement regulations upon the location of industry. Inasmuch as alternative policies will result in different distributions of benefits and costs, pressure groups, which are important institutions in our political system, will seek to influence the adoption of policies which will serve their own objectives. A determination of the incidence of costs and benefits would help the individual citizen determine the course of action that is in his own best interest. But beyond that it would provide the basis for determining how the costs of water quality management might be shared equitably—among levels of government and among individuals.

To sum up discussion of the five points we have just noted, I suggest that we start building a system of benefit-cost evaluation for water quality management that is broadly conceived and designed to facilitate intelligent decision making by public officials. Such a system must clearly differentiate among the different kinds of water quality deterioration. It must define the kinds of values which society may seek to optimize. It must translate the physical and biological effects of pollutants into measures of value, while taking into account the probable impact of technological change upon these values over time. The system itself must be designed to serve the political institutions through which decisions about water quality management are made.

From this general structure of the problem let us turn to a brief review of some lines of study which should be helpful in the design of a system of water quality evaluation. The following suggestions are offered:

1. *Determinations of the effect of many new chemicals upon living organisms, particularly people, and an assessment of alternative means of dealing with chemicals that have a toxic effect upon human and animal life.* It is my impression that we know too little about the biological effects of many new chemicals. I assume further that continuing study will be essential because new chemicals will continue to appear in industrial effluent and runoff from land areas where chemicals are applied for a variety of reasons. This may be the most serious problem confronting us at the present time because of its importance to public health. Until we know more about the effects of new chemicals and about alternative means of dealing with them, abatement policies and programs cannot be evaluated in any systematic manner.

2. *More precise determinations of the effects of different kinds of pollution contributed at a specified upstream location upon the quality of water at a specific downstream location under different streamflow conditions.* This should be done for each of the major classifications of pollution including organic pollution, heat pollution, etc. Until such effects are specified in a meaningful way, we have no way of knowing what the effect of pollution really is.

3. *Determinations of the cost of providing water of appropriate quality at a given downstream location to serve specified demands in the face of potential contributions of specified quantities and types of effluent at given points upstream.* This is a logical corollary to the second line of study suggested above. It would involve a comparison of the cost of eliminating the pollutant at the point of effluent discharge with the cost of upgrading the supply at the point where it is to be used. It should be emphasized that "costs" should be expressed in terms of different values such as health, aesthetic and market values.

4. *Determination of the incidence of costs and benefits under alternative methods of water quality management.* That is, who bears the costs and who receives the benefits? How do they fall upon individuals, communities, regions, and the nation?

5. *Examination of the effect of pollution abatement requirements upon industrial costs and in turn upon the location of industry.* Would

the availability of streams with large capacities to absorb wastes invite industries to locate in particular areas if certain standards of stream quality are specified?

6. *An assessment of the outlook for technological innovation as it might alter the water quality management problem in the future.* What techniques are on the horizon which will further complicate the pollution abatement problem? Also, what techniques are in prospect for dealing with pollution more effectively? What is the likelihood that these techniques will enter the picture; when, and what will be their impact?

There may be other important lines of study which should be pursued to arrive at a satisfactory system of evaluation for water quality management. This paper will have served its purpose if it provokes thought and discussion of the problem. My own view is that the adoption of sound policies and programs for pollution abatement depends upon the development of a systematic framework of evaluation.

## DISCUSSION

A. J. BIEMILLER
***Director***
***Department of Legislation, AFL-CIO***

On behalf of the American Federation of Labor and Congress of Industrial Organizations, I express the hope that this Conference will rise to its major challenge; to lay the groundwork for establishment of a comprehensive national policy for the control of water pollution; and to set forth a framework of progressive programs to achieve the goals of such a policy.

This Conference can be recorded as just another study group or it can be the catalyst for informed and wide debate on the question of what must be done and how best to do it.

Labor strongly objects to the President's message earlier this year rejecting legislation which would have liberalized the 1956 Water Pollution Act.

Far from being a "uniquely local blight," waste impregnated rivers and streams in the United States constitute an increasingly serious problem which in the aggregate is truly national.

Water is an indispensable natural resource on which every human use depends. Water that can't be used because it is filthy reduces present and future supply. It inhibits local, State, regional and national economic growth; it poses known and unknown dangers to public health; it curtails expansion of recreation; and further dislocates the already badly disrupted balance of nature.

Almost everybody with an interest in the problem agrees that water pollution is a bad thing and that it must be stopped.

There is general agreement that a greater effort must be exerted to clean up America's waters, if only because present programs are not keeping up with present requirements and because population growth and economic expansion over the next few decades will inexorably add to the dilemma.

It has been estimated that by 1975 there will be 230–240 million Americans using 453 billion gallons of water each day, a per capita daily use of 1,968 gallons.

If these forecasts are valid, there will be 50–60 million more Americans than in 1960, using an aggregate 112 billion gallons of water each day, with an average per capita use of 236 gallons more than the 1960 average individual use. It also means that about 88 percent of a total estimated supply of 515 billion gallons of usable water will be required to meet the needs of America in 1975, just 15 years from now. The United States used 60 percent of this supply in 1960 and only 8 percent in 1900.

Achieving abundant, clean supplies of water therefore will become crucial within the next two decades. To the extent that water pollution is not abated, there will be that much less water available for future requirements.

The great urban belts of the Atlantic and Pacific Coasts, and of the Middle West and Southwest, have already absorbed millions of people from farms and small towns. This process of urbanization is expected to gain momentum.

As a result a few river systems will be forced to carry an inordinate burden of human and industrial waste. Into these rivers are carried thousands of acres of topsoil washed into watercourses by spreading real estate developments, satellite areas to the great cities, public works of various kinds—planned and executed for the most part without regard for sound land conservation practices.

New varieties of industrial wastes created by new processes, chemical, atomic and others, have in large measure defied efforts to treat them. In some instances, they even interfere with treatment of conventional waste. Nuclear waste products dumped into running water have raised the spectre of radiation illnesses, adding to the potentially harmful but still largely undefined effects of the new chemical effluents.

The tremendous expansion of steam electric power stations using great quantities of water to generate electricity produces thermal contamination by raising water temperatures thus reducing the ability of streams to produce the oxygen needed to purify waste materials.

Finally, filthy water murders fish and wildlife and stands as a barrier to expansion of outdoor recreation. A recently published monograph by the United States Senate's Select Committee on National Water Resources indicates that by 1980 such recreation will demand the colossal total of 7.5 billion visitor days in national, State, county, and municipal parks, with water requirements for this purpose increasing more than 60 percent over those of 1960.

Labor, since the end of World War II, has become increasingly concerned over the country's mounting future needs and the failure thus far to plan and execute broad recreational programs to meet them.

The work week continues to shorten as productivity rises. Population, personal income levels, and length of paid vacations are increasing. Means of transportation and access to outdoor recreational areas continue to improve. Relatively few years ago, families of working people could scarcely have conceived of spending a week or more touring the Southwest, or camping in one of our national forests or parks, or visiting seashores or mountain resorts, recreation is now routine to hundreds of thousands.

Americans as vacationers, particularly to outdoor places, have made the recreation industry possibly the fastest growing in the United States. It is as truly a mass industry as the automobile industry. Therefore, programs to expand facilities must be based on mass demand, no matter what agency is involved.

It was not a "uniquely local blight" which created the broad interest and participation in this Conference and which brought together representatives of varied organizations, at all levels of government and of the public generally.

The question is not whether America should immediately shoulder the unmet task of water pollution abatement. To us, the question is when will we begin to carry out the broad policies and programs that are needed?

There are many irrelevant arguments that still stand in the way of progress. There is the one about "States rights" which ignores "States responsibilities." Then there is the one which places a sacred seal upon budgeting considerations and a secondary value to human needs. A much oversimplified argument which lulls the public into a sense of complacency holds that if such issues as water pollution are studied to death, somehow things will be put to right.

We believe that a national policy of water pollution control should be an integral part of a national policy on natural resources and energy. For the central problem is a unity. It has been expressed in terms of comprehensive, multiple-purpose resource development of regional river basins. Gifford Pinchot, many years ago, more practically called it "the use of the earth for the good of man."

River systems have a way of scorning surveyors' boundary lines. They persistently flow downstream. If there is any waste deposited in them, some of that waste is bound to plague the good people below, whether they live under the same or different political jurisdictions.

Labor through the years has had enough bitter experience with state-administered social and economic programs to view with any optimism proposals to perpetuate the theory that such questions as control of water pollution are best left to the exclusive province of the various states and their municipalities.

Under a national pollution policy, the United States must develop national standards for control of waste discharges. The closest approach toward this goal has been a few interstate compact agreements which have operated with only indifferent success. The states which have established standards and regulations have done so for the most part with little thought of how they might affect other states.

Sometimes rigorous state antipollution laws and regulations are placed into effect without recognizing the financial problems of localities called upon to comply with them. Many towns and cities are hard put to raise necessary capital for schools, playgrounds, roads and streets, public welfare and various community facilities. Sometimes the tax base is inadequate. Sometimes legal ceilings are placed on allowable municipal debts. Attempts to provide state funds to meet such situations, such as New York's Water Pollution Control Board, have not been of much avail.

There must be an increasing part played by the Federal Government to augment the modest 10-year grant program of aid to municipalities caught in the financial bind to build needed sewage treatments plants. Labor strongly endorsed the 1960 amendments to the 1956 act, which would have increased annual Federal authorization for this purpose from $50 million to $90 million over a 10-year period. Is even $90 million a year enough to stimulate construction of plants to a degree sufficient to do away with the backlog and meet future requirements?

The costs of water pollution control programs must be met under adequate programs which will enable communities to obtain financing for treatment facilities so that future needs can be planned for instead of suddenly erupting in the faces of the citizens of a community.

If control of water pollution is regarded as indispensable, then the economics of abatement cannot be ruled solely by the consideration of dollar reimbursement obtained from such devices as user charges. Certainly, protection of the public health and of outdoor, water-based recreation by multitudes of citizens are benefits of pollution abatement that have a most important place in all policy goals and program planning.

The use of long-range public budgeting in the future, aided by a Federal capital budget, would aid in obtaining a realistic fiscal appraisal of investments made on both short and long term approaches in the public sector of the economy.

Labor continues to feel strongly that the regional river basin approach is the best yet discovered for dealing with land and water development and conservation. Water uses and pollution problems may vary considerably from one river system to the next for many reasons.

Regional authorities could be established to develop flexible standards and regulations for pollution control programs. They could be Federal corporations responsible to Congress for regulating water pollution activities, acting as the agency responsible for carrying out a grants-in-aid or low interest loan program to states and municipalities. They could provide a continuing program to handle municipal and industrial wastes and to set standards of how clean water must be and of plant design and operation. Such standards would have to be met by State or local entities before financial assistance would be forthcoming.

Those levels of government and private industry not in need of Federal aid would be required to meet standards imposed by the regional corporations in planning and constructing any waste treatment plants.

The regional corporation would also undertake intensive research and development, pilot and demonstration programs with the goal of both understanding the causes and effects of water pollution and how to abate it.

The AFL-CIO strongly feels that the national anarchy in water pollution control policy and programs must be ended if the indispensable resource that flows in our rivers, that is contained in our lakes and underground reservoirs and that washes our coasts is to be fully used. Quality control of water will largely determine if a water supply upon which nature has placed definite limits can be used to those limits or not.

The immediate needs consist in setting forth the dimensions of the problem so that every citizen may know its seriousness, in determining by full and informed public debate how the job may best be done, and in setting about doing it without further needless delay.

## Panel I

### General Discussion

**Mayor McCANN.** Before getting into the question period, I would like to recognize at this time Mr. William E. Towell, the director of the Missouri Conservation Commission, for a brief statement on what has been presented by Mr. Burroughs.

**Mr. TOWELL.** Mr. Burroughs in speaking for industry makes several statements I cannot let go unchallenged.

He says that because streams and lakes have ability to purify themselves that they have always been used for disposal of aqueous wastes. My comment to that statement is: Does that condition make it any less wrong if such disposal endangers health and happiness of all mankind?

Mr. Burroughs further states that farmers and municipalities are less closely controlled than industry in discharge of wastes. And if he is right, which I doubt, does any one wrong justify another?

Mr. Burroughs states: "It has not been firmly established that water quality is significantly impaired by temperature changes." I might add here that in addition to the printed statement he added "as far as I know." Let me suggest to him that he might change this opinion after only a few moments' talk with almost any fisheries biologist.

The next statement by Mr. Burroughs is one that invites rebuttal. He says that traditionally industry has discharged limited amounts of wastes into lakes and rivers without objectionable effects, and here again he added "in many cases." If this is true, and if municipalities and agriculturists can claim an equally fine record, we might just as well close this Conference and all go home.

Another quote: "Industrial management for the most part does not believe that pollution of industrial water supplies will increase to more critical levels in the future." I hope he is right. But I wonder if he thinks our population explosion with all its added production demands can be handled without strict pollution enforcement right now.

Might I suggest to our industry friends and to all others at this Conference that the time has come to stop saying there is no pollution problem or that it is a local or a state problem or that the problem is almost solved or that we need more research or that soil erosion is the real problem or that we need another Conference. Instead, let us adopt here and now a new philosophy regarding pollution, a philosophy which will embody this thinking: First, that water shall be kept as free as possible of wastes—not seeing how much they can safely absorb; second, that those who use public waters have a responsibility for returning them at least as clean as they were received; and, lastly, that no user of public waters has an inherent right to pollute.

**Mayor McCANN.** Mr. Towell, thank you very much for those comments, and I would like to make them part of the record for consideration in this evening's panel, if you would give them to Mr. Svore.

**Mr. GORDON.** This question was asked by Mr. Harry Schlenz, Water and Sewage Works Manufacturers Association: ***"In the address by Mark Hollis in the opening session on Monday and in your paper, reference is made to synthetic organic chemicals. If such***

***materials persist in defying an attempt to remove them by sewage treatment and water treatment means of an economical nature, should there be legislation to prevent their use in commercial products which are sold throughout the country?"***

My answer to that is that first this is one of those things that sneaked up on all of us. Many of us were not aware of the implications of some of these synthetics. But since we have gotten as far into it as we have, the solution seems to be one that should be found by both the producers of the synthetics and the Federal agencies through their laboratory facilities. I don't think that you can just *per se* recommend legislation to prevent the use of such commercial products at this stage of the game. It's too late—unless we find upon further study that human beings and the things upon which they depend are being very seriously affected.

The other question is by Fred A. Thompson, Director of the New Mexico Department of Game and Fish. Here is a question from a biologist: ***"Will you please discuss the effect of soil erosion as a pollutant especially in our Western States?"***

This is one that will take just a couple of minutes to answer. First, I did not attempt to cover it except as it applied to the dredging, gravel dredging, operations on salmon and steelhead rivers in the West. In my judgment, this is one of the most important phases of this whole pollution problem, and ordinarily we don't look upon it as pollution. It's not so classified generally.

But you have about four different kinds. First, careless farming, failure to apply soil conservation practices. Two, in the West, overgrazed watersheds which in many cases not only cause clogging of streams but also are responsible for intensifying floods. Third, we have careless lumbering and improper placement of roads and skidways in a large number of areas on private lands which are responsible for destroying streams. Fourth, you have our own State highway builders from one end of the country to the other through careless disposal of material from excavations which they don't intend to use for fill. All of these things are bad, and we must work diligently for the elimination of erosion which destroys our streams.

**Mr. GREGG.** This is a question from Fred E. Tucker of the National Steel Corp. ***"To obtain the fullest beneficial usage of our streams, effective regulatory bodies have adopted the practice that the discharge into a stream should be governed by the full assimilative capacity as measured at the point of use. What is your thinking on this?"***

This question strikes very close to the heart of the pollution controversy. It can be described, I think, by trying to determine what quality we want in our waters and eventually will be answered by the kind of research suggested by Irving Fox. We may assume, for instance, that we are going to use the full assimilative capacity, and as soon as we add another increment of pollution in oxygen demand or any other measure, we begin to knock off certain values. As you begin to decrease the esthetic value, eventually it's not satisfactory for drinking, for making highballs, or for swimming, fishing, boating, and so on. So each increment that is made for waste assimilation does have an effect. And the word "full" or "reasonable" has no meaning at this time because we don't have the criteria by which to measure them.

I would say that certainly we should use streams for the full assimilative capacity that they have for absorbing waste, but I am quite certain that I would not define "full" in exactly the same way that I might if I operated a pulp mill, for instance.

The Izaak Walton exposition is, if we do the very best we can in public policy and as private citizens and industries in abating pollution, we will be very fortunate just to keep even. If we begin by saying that we are going to use waters to the maximum capacity for waste treatment, we will maintain them at a level which is just above that required to keep from killing each other, but we certainly won't be taking full advantage of the waters' capacity to serve the widest range of human uses, including recreation.

Let me go back and second-guess myself. I should make one thing very clear: that conservation people, including those on this panel, clearly recognize that we need the industrial society and that our streams are going to be used to receive process waters and so on. We accept it. We're glad about it. We have to eat, wear clothes, and so on, ourselves. And in presenting these points of view I hope they're not interpreted as being incorrigibly hostile to the interests of industry. I have to eat just like anybody else does.

This is a question from A. F. Dappert of the New York Water Pollution Control Board: ***"What can conservation groups such as the Izaak Walton League do or what is being done to educate owners or operators of marine toilet-equipped water craft to so equip or operate boats as to prevent the pollution of water?"***

I'm not competent to speak nationally. I can say that in several states that I'm familiar with, our organization has supported or initiated legislation to render marine toilets inoperative on inland waters.

In Illinois the State Conservation Department has initiated legislation, and we have supported similar legislation in Wisconsin and in Minnesota. I think that with your permission I will ask Seth Gordon to comment further on that. He might have something specific.

But as far as inland waterways are concerned, our position has been that until proven methods of chemical or other treatment of wastes are available we will support legislation to keep them inoperative.

**Mr. GORDON.** I hate to get into this because it is a very big subject. This is one of the problems that has confronted all of us, and more and more we're coming to a realization that if you must provide toilet facilities around certain reservoirs that are being used by the public and deny people the right to use craft which have toilets on them, you certainly will have to get into this very problem of what to do with all of the craft that now use facilities. Sooner or later, believe it or not, you're going to be into it in a big way, because a lot of these vessels that come into our harbors have been in the habit of dumping all of their filth overboard right there. Some of them are occupied by large numbers of men, military and others, that are spilling wastes into bays and harbors in large volume—volume of the kind where we would say to a facility on shore, "You have to clean it up."

Sooner or later ships must be so designed that the wastes can either be pumped ashore and taken to a sewage treatment plant or treated on board in some way.

**Mayor McCANN.** I'll recognize at this time Jack Palmer of the Izaak Walton League, Illinois State division president.

**Mr. PALMER.** I don't know whether this is the time to say this or not, but I'm rather amazed at the number of people that think pollution is something that is moderate, that it's new. It is not.

In 1922, in October to be exact, Dr. Henshall, in the Izaak Walton League paper—*Outdoor America,* which is what we call it now—printed an article on pollution just covering the same points that we are covering today, with the exception of the insecticides and pesticides. I hope that 38 years from now we do not have the same problems coming up that we do today.

Our pollution problems in those days covered industrial as well as agricultural states from New York to Wisconsin, to New Orleans, and the entire Midwest. They are the same that we have today.

**Mayor McCANN.** Mr. F. J. Coughlin, the Association of American Soap and Glycerine Manufacturers would like to make a statement.

**Mr. COUGHLIN.** I'd like to pick up the point about the toxic impact of new chemicals, whatever their source, and agree immediately with everyone who says that more needs to be done in order to evaluate their safety.

It seems to me it's important to consider ways and means of doing this efficiently. My suggestion is that we use a direct approach by measuring the effects of these substances in drinking water as contrasted with raw water. This would eliminate much unnecessary expenditure of manpower and money in safety evaluations which would have to be undertaken if it were necessary to study all the materials that are present in the raw water supplies, but which are not present in drinking water, especially after it has received municipal treatment.

The problem of the evaluation of safety of residues of surface-active agents from detergents illustrates this point. First, there are tremendous amounts of detergents used by the women in this country, and in passing I should say that this use contributes to cleanliness and has a tremendous impact on public health. Now, in spite of the amounts used, only trace levels reach water supplies. For example, the Ohio River below Cincinnati over the past 5 years has averaged about 0.16 of one part per million of ABS, which is alkyl benzene sulfonate, the surfactant present in maybe three-quarters of the household synthetic detergent tonnage which is sold through the grocery store channels. This data has been published in the May, 1960 *Journal of the American Waterworks Association*, pages 607–12.

In considering the possible effects of detergent residues on humans, feeding studies have been completed on rats, feeding them at a thousand and five thousand parts per million of ABS in their diet. Rats fed the test substance were just as normal as the control rats, and this is for their lifespan of two years.

A second study in which the rats were administered the surfactant in their drinking water confirmed the first and establishes that, using the best toxicological techniques, there is no health hazard from detergent residues. These studies have been published in *Toxicology and Applied Pharmacology*, July 1960, pp. 464–473.

I'd like to go back to the point about the use of drinking water as a basis for safety evaluations. Spot checks of Cincinnati drinking water, after treatment, show that the level of the detergent surfactant residue has been reduced from the 0.16 ppm, the average for the Ohio River, to less than 0.03 ppm and this is in ordinary treatment. Thus it is apparent that there is a considerable removal of detergent residues. I believe this is true also for other organic matter which occurs in raw water when you think of the changes that occur from treatment of drinking water.

**Mayor McCANN.** Mr. L. C. Burroughs has several questions. Also he has an opportunity to rebut Mr. Towell's comment if he likes.

**Mr. BURROUGHS.** Mr. Chairman, I don't think this is the proper place for debate. I do, however, want to make this comment about what Mr. Towell said: All treated waste water will contain contaminants. There will never be a time when treated water, be it industrial or municipal water, does not contain some level of contaminants. It is a matter of opinion as to what standards of receiving water quality define the levels at which wastes may be discharged.

I am not, of course, suggesting harmful amounts be discharged into any stream, and I should like to inform Mr. Towell that I have quite a bit of information about the effect of temperature, and I do recognize the fact that there are many instances where temperature pollution is harmful. I feel that this subject is being overtalked about right now.

I believe the time should come soon when we can quit talking about temperature pollution as being such a tremendously serious thing.

This question was asked by Mr. W. H. Jukkola of Jones and Laughlin Steel Corporation, Pittsburgh: ***"In view of the fundamental concept that a beneficial use of streams is to carry away wastes, should treatment of these wastes be provided beyond that necessary to protect other established uses?"***

It is impossible to know exactly what is a satisfactory treatment level. It is not that clearly defined.

Almost all industrial plants are discharging wastes into streams with other industrial wastes and with municipal wastes, so that if an industrial plant is required to put in a waste treatment plant most certainly it should be built with some extra capacity. It is good economic sense to build a plant with extra capacity if one has to be put in, because certainly that extra capacity will be needed before much time has passed.

Mr. Jukkola adds: ***"Is it not a proper function for those affected together with local or regional authorities to determine these beneficial uses in the over-all public interest?"***

I would say that is correct. It is one of their functions. But no industrial plant should stick its head in the sand so to speak and wait for somebody to come after it.

An industrial plant certainly should be aware of the effects of the wastes it is discharging, and if these wastes are harmful and objectionable that industrial plant should do something about it.

Mr. Towell has directed this question to Mr. Watson who is not here, but I'll attempt to supply an answer. The question is: ***"Mr. Watson lists two requirements for location of a new industrial plant—(1), a sound source of water, and (2), a satisfactory waste control climate. By 'waste control climate' does he mean a locality that will turn its back on added pollution just to acquire the new industry?"***

No community is long going to turn its back on objectionable pollution. Actually today new plants are required in most States to provide adequate treatment facilities at the time of construction.

I think what Mr. Watson had in mind was this: That such things as waste discharge into a city sewer, for example, can be an extremely expensive thing if the city charges high rates for such discharges. There may be unnecessarily restrictive waste water quality limits in that area set by control people, limits that an industrial plant feels that they would not wish to attempt to conform with.

Another thing, of course, that enters into this picture are the opinions of people involved. These will vary greatly as to the elements that might make up what is known as a waste control climate. I am sure that no industrial plant would ask for an exemption which would permit it to discharge harmful amounts of wastes, because such an exemption would certainly not hold for very long.

This question was asked by Mr. Jack Palmer, with the Izaak Walton League, Illinois State Division, says: ***"You have mentioned that a satisfactory waste control climate is an important element in decisions on plant locations. Would being required to maintain water in condition suitable for recreation be considered unsatisfactory?"***

This certainly would not be considered unsatisfactory. A plant must provide a level of waste treatment that will maintain satisfactory conditions in the receiving waters, and recreation is one of the important uses of lakes and streams. I hope I have defined what Mr. Watson had in mind.

This question was asked by Mr. Duke Reed, Cook County Clean Streams Committee, Forest Preserve District: ***"What can be done to reduce 'one-shot' or accidental pollution of streams by the frequent practice of running power house, airport, industrial, et cetera, floor drains to storm sewers?"***

This is a question that must be answered by each industrial plant or each location. I don't believe a general answer to such a question would suffice.

In the oil industry we usually provide separators and ponds or basins on our waste water sewers to catch any accidental discharges of oil. A pipeline could break during the night releasing large volumes of oil to a sewer. Likewise due to equipment failure, chemicals could be discharged which would cause pollutive concentrations of chemicals outside of an industrial plant. Steps are being taken to minimize these possibilities in existing plants and in the installation of new facilities.

This question was asked by Mr. Roy Weston: ***"What is the cost of complete waste treatment in the petroleum industry based on cost of product?"***

The cost of complete waste treatment is a rather vague thing and will vary greatly from one refinery to another depending on the size of the refinery, the products being manufactured, the type of crude oil being run, and many other factors. I do not believe this question can be answered except on the basis of one individual plant or another.

He also adds: ***"How does the cost compare to gasoline tax?"***

The cost is very small compared to the gasoline tax. The public pays the tax, of course, and where the tax may be 11 cents the cost of waste water treatment may be a very small fraction of one cent. The refinery price of gasoline is about the same as the gasoline tax. Allowing for costs of manufacture, the cost of crude oil, and other expenses, the actual profit per gallon of gasoline is only a very few cents. Waste treatment costs are more significant in this frame work of comparison.

***"How does this cost affect profits?"*** The cost will affect profits by the amount of the cost, whatever it happens to be for a specific refinery. There is no one answer to this question.

This question was asked by Dr. Clair Boruff, Water Pollution Control Advisory Board: ***"How may Federal, State and local governments aid industry and encourage waste abatement?"***

For the most part, industrial plants feel it is their responsibility to investigate and develop solutions to their own water pollution problems. Such study must include consideration of correction not only through treatment of the wastes but by changes in manufacturing equipment and procedures. Such changes may very well involve not only product quality but also capital layouts, unit production costs, and ability to compete in a free market.

Industrial water pollution problems can be investigated only by experienced industrial technologists capable of examining the feasibility of each possible corrective measure. Such studies are expensive and time-consuming. The industrial plant pays for the investigation, pays for the treatment facility, pays local and State taxes on the facilities, and pays a continuous cost for daily operation of the facilities. On the other hand, municipalities, also recognized as major sources of stream pollution, have the benefit of Federal and State scientists and laboratories for investigation and research, and receive Federal grants towards construction of waste treatment installations. Industry taxes at the Federal, State and local levels pay a large percentage of the capital cost of municipal sewage treatment plants and of their daily operating expenses. Further sizeable increases in Federal appropriations for municipal sewage treatment plants would increase industry's tax contribution.

Most industrial plants know how to improve the quality of their waste waters, but the costs are prohibitively high for many. Federal, State and local governments could do much to increase construction of industrial waste treatment facilities by providing financial incentives. It is suggested that this could be accomplished at the Federal level by permitting industry to consider the cost of waste treatment facilities as an expense item for tax purposes. State and local governments could also help by exempting these facilities from property taxes.

**Mr. FOX.** This question was asked by Mr. Jack Palmer of the Izaak Walton League, the Illinois State division president: ***"You have outlined basic points of a system of evaluating costs and benefits in making decisions in waste pollution control. Will you please elaborate further on how and by whom such a system could be set up?"***

If you would ask me that question 6 months or so from now I would be in a better position to answer it. One of the things we are hoping to do at Resources For the Future beginning about the first of the year, is to initiate some studies in the problem of evaluation of water pollution abatement measures or water quality management.

I will make just a couple of observations at this point. First, on the question of by whom should such a system be set up, I feel there is a role and a responsibility for a great many different people and institutions in such an endeavor. It would be helpful to have aggressive leadership by the Federal Government in this field. There has to be leadership in order to focus the efforts of various interests and groups that can take part in an undertaking of this kind.

As I said in my paper, it is essential that there be work not only by, say, the economists and people concerned with the social sciences, but also by a number of disciplines in the physical sciences.

I think it is likely that we do not have the kind of data required for a good system of evaluation, and to secure these data there must be communication and considerable joint effort by several disciplines.

Beyond the leadership of the Federal Governent, work by universities, industry and State governments, in different parts of the country under quite different conditions will be urgently needed.

This question was asked by Mr. A. W. Albert of the Vermont State Water Conservation Board: ***"Does your cost-benefit evaluation propose the elimination or the modification of the riparian rights doctrine?"***

Well, it proposes nothing with regard to water rights. The possible effect of the research I have suggested on water rights is a good question. I would like to observe this: As all of you know, we have had considerable discussion in recent years about modification of water allocation law. My own judgment is that we have made relatively little progress because we have failed to take into account the significance of recreation and the impact on water quality of waste disposal in considering adjustments in water law. Until we know much more than we now do about what is involved in allocating water rights to various uses, including recreation use by the public, and about how to take into account the waste disposal problem, we won't proceed very far.

In specific answer to Mr. Albert's question I anticipate that as we get into this matter farther and understand water quality management better, some modification of the riparian rights doctrine will result.

This question was asked by Mr. Roy F. Weston: ***"You have inferred that pollution abatement can be justified economically. Will you propose that pollution abatement be limited to those cases in which the economic advantages of such abatement are clearly indicated?"***

This is a good question and it gives me an opportunity to clarify a point. It depends on what you mean by the term "economic." When speaking of "economic," if you mean those values that can be measured in dollar terms, then I did not infer that you would justify abatement on the basis of "economic" considerations alone. I was talking about a variety of considerations, including esthetic considerations, health considerations, and then what I called market values.

I would be the first to say—in fact, I feel quite strongly—that one of the major limitations of benefit-cost analysis as it has been applied in the water resources field is that existing practices have not provided a good approach to considering those aspects of water management that are not measurable in dollar terms.

This question was asked by Rev. John Cortelyou of DePaul University: ***"You suggest that the many new chemical substances now considered as pollutants should be looked at realistically with respect to their effects on biological systems, particularly the human. The effects on the human system may be a long time making their appearance on a sufficient segment of the population to permit one to make a black or white statement about the effect of this or other pollutants. Should not the attempt to systematize begin with biological systems that lend themselves more readily to experimental animals?"***

It would have been better if either Dr. Kehoe or Dr. Teague had been available to answer this question.

I assume that the answer is yes, that you no doubt would consider experimentation with lower forms of animal life first. But I wish to make one other observation because I think it is pertinent to this particular point, namely, that by suggesting the need for study and analysis of the pollution abatement problem for evaluation purposes I'm not suggesting that we should stand still in the policy field until we get all of the information that would be desirable. An effort of this kind should go forward in both ways. We do not know enough. We have got to understand much better what is involved in water quality management. At the same time there is much room for action on the basis of what we already know.

**Mrs. OZBIRN.** This question was asked by Mrs. J. A. Booras, President of the Federation of Homemakers: ***"Since there seems to be concern about farm pesticides contaminating streams to lessen recreational activities, what effect do these pesticides have on foods, since we're told many of these pesticides are toxic and cumulative in the body?"***

I would seriously doubt that there is anyone in this room that would have the accurate answer to that question. However, I will repeat what I said this afternoon, and not being an expert I will say this and speak a little carelessly perhaps. I would say that to a certain extent these pesticides do have an effect on foods, but the question is to what extent? This could best be answered by a chemist. Also, I do know that the Department of Agriculture and the Department of Interior are giving attention to this problem.

The recent episode of the contaminated cranberry was an example of this problem of food and pesticides. This problem needs attention.

**Mr. CURRAN.** This question was asked by Mr. R. M. Dixon, Texas Board of Water Engineers: ***"You alluded to the inability of some***

***cities to finance treatment works and indicated Federal financial assistance as the single source of funds to make up this deficiency. Do you disagree or do you agree that special districts with taxing powers would be able to provide a satisfactory local agency to do this job at the local level where primary responsibility should rest, assuming taxable properties are available and adequate?"***

My reply is that if a local agency can finance treatment works and needs no Federal funds, by all means they should go ahead with getting the job done.

**Mayor McCANN.** The Chairman has a question from Mr. Sam Paradiso of Eli Lilly Co. of Lafayette, Ind.: ***"We know that temperature variations in rivers may amount to 50 degrees Fahrenheit and over. At what temperatures are conditions critical and where have these conditions been noted?"***

I wonder if some chemist or biologist in the audience would answer that question for this gentleman and state your authority, please. Would you step to the microphone and state your name and what authority you use for answering this question, please?

**Mr. JACOBS.** I would not answer this on my own authority. I am Harold Jacobs, chairman of the Delaware Water Pollution Commission. The Academy of Natural Sciences of Philadelphia has run quite a number of tests on the effects of temperature on fish. The top temperature that fish can stand will, of course, vary with the fish, the type of fish, and what they are used to. The temperature which should not be exceeded is somewhere near thirty-five degrees, which would be somewhere around 100 degrees Fahrenheit. That does not mean you should run your rivers at that.

**Mayor McCANN.** Thank you very much for your help and assistance.

**Mr. JACOBS.** May I make a short statement?

**Mayor McCANN.** Yes, you may.

**Mr. JACOBS.** I have been thinking of this point as I have been listening to the requests for Federal aid.

Every year I have to go before a budget committee to obtain funds for the Delaware Water Pollution Commission to operate. I have yet to find a private citizen that has given any assistance to me or to my colleagues in obtaining those funds. We accept the Federal funds. Privately, we wish that we did not have to accept Federal funds.

I think one thing this Conference should decide is that all of us should go back and at the local level campaign for the strengthening and improvement of the operations of our Commissions and Boards that have this job to do and stop crying for the Federal Government to do the job for us. We ought to be ashamed of ourselves if we can't do it locally.

# PANEL II

*Tuesday, December 13*

## Meeting the Growing Competition for Water

*Pollution Control as a Means of Increasing Water Supplies*

**Chairman**
DR. E. A. ACKERMAN
*Executive Officer, Carnegie Institution of Washington, Wash., D.C.*

**Co-Chairman**
RAY E. LAWRENCE
*President, Water Pollution Control Federation; Partner, Black & Veatch, Consulting Engineers, Kansas City, Mo.*

**Public Health Service Resource Personnel**
K. S. KRAUSE
W. W. TOWNE
L. F. WARRICK

### Morning Session

**Dr. E. A. Ackerman, *Presiding***

Good morning. This is Panel II, "Pollution Control as a Means of Increasing Water Supplies."

Ray Lawrence, of Kansas City, and President of the Water Pollution Control Federation, and I are co-chairmen.

We now really begin the working sessions, or the working session, of the conference.

The theme for this session, and for the conclusions which we hope the panel will eventually present, I think is fairly clearly stated in the title, that is, water as a means of meeting water supplies.

By way of directing our attention just a little more in detail, I think we might keep in mind as we go along the questions which Surgeon General Burney put before the entire Conference yesterday. He had, I think, four or five different questions: What research areas are most urgent? What levels of national support are needed and who shall provide them? What new parameters do we need in order to obtain a true picture of water quality? What shall be our national policy on the utilization of streams for waste disposal? How much shall we spend controlling pollution and how should these costs be apportioned? How do these costs compare with the cost of neglect? Finally, what steps should be taken and by whom when justly apportioned responsibilities are not met?

These are questions which I think the Surgeon General was not only speaking for the Public Health Service but probably for the Nation at large when he set those down.

# Water Quality Management— A National Necessity

CLARENCE W. KLASSEN
***Technical Secretary***
***Illinois State Sanitary Water Board***

A supply of water adequate in quantity and satisfactory in quality for all future domestic and industrial uses in United States might be considered an engineer's dream—it is something that can be accomplished so far as engineering technology is concerned; however, in some areas of the United States it may not be accomplished for reasons which have little or nothing to do with engineering. It may be a question of money, where cities and other political subdivisions unable to appreciate water's value would not finance such projects, or where private industrial interests are not yet convinced of the need for or the monetary return on their investment. In some areas, a clash of local interests may be an obstacle; in others, necessary water development may remain in the "dream stage" because of political difficulties.

Technical considerations in such a country-wide program are based upon real and ascertainable factors such as geology, rainfall, runoff, pumps, pipelines, and treatment works. Political or governmental considerations often based upon administration or tradition, may involve uncertain factors. Public considerations often through lack of knowledge and appreciation may assume intangible proportions.

Uncertainties in potentially motivating factors may through knowledge, understanding, and appreciation change from the politically impossible or the economically unfeasible to the favorable. Financial considerations become real when the economics are considered. Opportunities become real when such factors as price, tradition, and administration become clarified. The urgent need for coordinated action becomes apparent when the seriousness of the problem and potential solutions are considered. This particular paper is presented in the hopes that it will stimulate understanding, promote appreciation, and motivate the evaluation for the steps necessary to accomplish the objective—a national program of water quality management.

### Supply Must Meet Demand

It has been said that whenever something is wrong, something is too big. If a community grows beyond its optimum size or an industry develops beyond its planned capacity, the resulting problems eventually outstrip the development or expansion. Our present water problem has been given this same type of reasoning. The dire predictions of inadequate water for our future industrial and urban growth are based upon the projected demands being "too big" for the supply. This might have some basis if we continued without reducing wastes, increasing efficient use, and controlling pollution; however, we cannot afford to even consider this concept of shackling our industrial and community growth to limitations imposed by what is *presently* considered available, usable water. On the contrary, we must set our target objective to make whatever the amount of water that *is* or *will be available*, meet whatever demands that are or will be imposed upon its use. This is technically possible.

To supply a demand with a product that can be economically produced is a traditional problem of management. It is being done every day through free enterprise and is basically what has made us a great nation. The management of our water resources, particularly its quality, is a concept new to some, but to many it is merely the common sense application of known principles of management.

We are not running out of water if we put to use our knowledge and prudent measures to make better use of what we have. While we do need some additional "technical tools," we are not making full use of all we now have. We are not making full use of our present knowledge of preserving and protecting water quality.

The technical aspects are not the serious or major questions. The principal question is whether we as a people honestly desire and can economically afford to meet water quality demands. Probably of more significance—how long can we continue *not* to afford to meet necessary water quality criteria?

### Water As A Resource

When we consider the natural resources that we have and can utilize to build the foundation of our economy, we can evaluate these resources in many ways—all of them except water. As a resource, water is a requirement so basic to this country's existence and economy that the use of all other resources are either dependent upon a plentiful supply of water or in its absence, other resources are valueless for use and development. While many of our natural resources vanish with use, the usage of water merely produces changes in its position, quantity, and quality.

Regardless of its particular source, be it wells, lakes, springs or rivers, the origin of all of this country's water is in some form of precipitation such as rainfall, snow, dew, or hail. From the earth it returns to the atmosphere by evaporation from the seas, lakes, and rivers, and by transpiration from plants only again to return to the earth, an endless cycle which has been repeating itself for centuries. Water is not manufactured nor destroyed. In its various forms as a liquid, vapor or solid, there is no more water now than a thousand years ago, and a thousand years from now there will be no more water than at present. Water *is* a limited resource, a limited commodity, and we must not be deterred from that concept.

When in its cycle, water leaves the clouds each time for its travel to the earth, it is pure bacterially and minerally but by the time it has percolated into the ground or flowed into a lake or stream and is ready to be withdrawn for use, its original pure state has always been changed minerally and bacterially, depending upon the pollutional material with which it has come in contact, either from natural or man-made sources. A major question in developing a suitable source of water for domestic or industrial consumption is "how near to the original mineral and bacterial pure state is necessary, desirable, or economical?" The answer to this question obviously must be determined by the many factors and considerations involved in each particular local area. The engineer planning works for using a water source is usually confronted with a simple problem in economics, that of providing an adequate amount of suitable quality within the limits of the money available and the quality that is warranted.

We have read that there is no over-all national water problem. This statement related to quantity may be true for the major water problem most frequently encountered is that of having the right amount of water of proper quality at the right time and place; however, we do have an over-all national water problem. *Regardless of location, the current national water resources problem is that of maintaining the quality of our new and used water suitable for reuse.*

## Demands and Supply

In considering the demand for use of water, both present and future an incomplete picture results unless we differentiate between consumptive uses which physically remove the water molecules by evaporation or transpiration, and nonconsumptive uses which return the water to its source without diminishing it in quantity. It has been common to combine nonconsumptive and consumptive uses when estimating total water withdrawals or uses. A true picture of available water irrespective of quality can only be secured by differentiation between these two types of uses.

First, let us consider the over-all supply, demands, and their distribution. Based upon data from reports of the Senate Select Committee on National Water Resources, the United States has an average of 30 inches of rainfall annually which results in 4,300 billion gallons of water daily. Of this, 3,100 billion gallons or 70 percent is consumed through evaporation and transpiration; however, we cannot consider this all "lost" as it supports cultivated crops, forests and native grass. This amount cannot be considered in the ordinary sense of manageable water. The remaining 30 percent or 1,200 billion gallons can be considered manageable; however, at present about two-thirds or 800 billion gallons a day of this drains from the land, some soaks into the ground, and the remainder flows off into the lakes, streams, and into the oceans. During its flow much of it serves and must be available as water for navigation, water power, recreation, and also as a vehicle for transporting wastes, both domestic and industrial, natural and man-made. At present, one-third of this manageable water or 400 billion gallons is withdrawn and used for industrial and domestic purposes. Of this amount withdrawn, 130 billion gallons can be considered consumptive for it is lost through evaporation, transpiration and consumed in manufactured products. The remaining 270 billion gallons constitute a nonconsumptive use and are returned to the surface streams as the spent industrial or domestic water. This is the quantity particularly amenable to quality control.

The over-all amounts of consumptive and nonconsumptive water will differ according to the water use. At present our water withdrawals are as follows:

| Use | Percent of total | Percent of use consumptive |
|---|---|---|
| Irrigation | 46 | 60 |
| Industry | 46 | 2 |
| Public use | 8 | 10 |

Factors affecting a material future increase in irrigation (and its correspondingly high consumptive use) are complex and involve such things as Federal financing of high-cost irrigation projects, low-cost alternates for increasing agricultural production, and various regional political considerations. Some authorities have indicated that a material increase in the use of water for irrigation is questionable. It is generally accepted that industrial and domestic uses will account for major future increases.

It is estimated that in 1980, the Eastern states will need 200 percent more water than presently used or 450 billion gallons per day. The Western states are estimated to need an increase of 50 percent over their present use or 180 billion gallons. Based upon our present type of uses and considering the present wastage and absence of conservation measures, this 630 b.g.d. amount required in 1980 will closely approach the total amount of estimated available manageable water. This daily increase must either come from the 800 billion gallons now used in replenishing ground water, for navigation, water power and recreation, or through additional reuse of the present spent water consumption, or, most probably, a combination of these two. The already competitive uses will be sharpened. Ground water recharge by necessity is increasing. Navigation and water power uses will need at least their present amount and recreational authorities have indicated an increase in the amount of water desirable for that particular purpose.

This brings into sharp focus all of the factors involved in making reusable the water that has already been used at least once.

The "desalting" of saline water has been hailed as an important and promising factor in supplying needed potable water in the future; however, it is highly probable that the demineralization of our spent water supply (normally referred to as sewage) will be a more practical and feasible means of converting presently undesirable water to one of usable quality. A problem of aesthetics rather than techniques would be involved. However, we must face the inevitable fact that we all cannot continue to enjoy the luxury of using water only once and discarding it. It could be said that "everybody can't live upstream."

Again on the positive side of additional future available water, as wastes are more adequately treated, at least a portion of the minimum low flows now needed for dilution would become available.

Water quality management and control revolve around those materials remaining in the water from a previous exposure or use that render it unfit for reuse. Problems involved in reuse obviously include the prevention from entrance and the removal after entrance of such materials that are and will render water unfit. While minor in quantity, they are major in importance. The control of quality through the control of pollution is the basis for, is fundamental to and is the key in water quality management.

## Water Quality Management

Actually, what is water quality management? First of all, it is nothing new. We have had it in operation in various areas, to some degree, for many years. Now it must be multiplied in scope, common sense, and by intelligence.

Many of the principles that apply to the prevention, abatement, and control of pollution can, with little or no modification, be applied to what we can call water quality management—both have as their basis, water use. The allocation of water use (although not normally referred to by pollution agencies in those terms) is based upon the consideration of quality and quantity. Water use is the basis for every practical and effective water pollution control program. Determining the necessary degree of treatment is based upon the use of the stream below the particular point of discharge and considering the dilution afforded. The application of these principles has been in actual use by successful state water pollution control agencies for many years.

Water quality management is a profession, an art, and a science. It is a profession because of certain known facts and principles that have been developed by predecessors in the various fields of water pollution control. It is an art because it requires the interweaving and application of certain specific technical, legal, and political skills. It is a science because there is a great accumulation of knowledge, facts, and phenomena which is accessible and which has resulted in established principles to guide its basic activities.

Water quality management has the responsibility of accomplishing the target objective of an adequate supply of water of quality satisfactory for all uses. This is and can be attained through the efforts of other people—those agencies already functioning within our pattern of local, state, and Federal government. However, on a national scale, at least initially, a water quality management program should give direction to and develop people to have an appreciation of its basic concepts—dispelling such concepts that water can be misused at no cost. It must initially develop a greater appreciation of the over-all problem in the minds of many business men who at the present time have limited their interest in water to merely obtaining it at low cost for their own plants. It must encourage the adoption of a broader view to a constructive and positive position, to protect the future of industry and the country's population. The skills involved in water quality management must be directed toward maintaining the economic health of water use, integrating the viewpoints of water users and water's function, instilling the over-all "service to the country motive," and providing an organized pattern that is dynamic, practical, and acceptable. More in detail, these would involve the forecasting of use of supply, the planning, organization, establishing and maintaining controls, reviews, appraisals, and proper communications.

Water quality management must adopt the concept that pollution of our ground and surface water resources is not solely a problem involving public health, nor fish and wildlife, nor agriculture, nor industry, nor navigation, nor power, but rather it is the combined problem of all of these interests and cannot be solved by considering them separately. Pollution as it affects water quality management is objectionable only in relation to the intended use of the water. The concept of water quality management must include the knowledge that we are living in an age of synthesis and that any particular form of water use is a part of something else. No field of activity demonstrates better the need and importance of combining and blending the quality of different sciences and different professional personnel to meet our target objective. Unfortunately, water quality control, it seems, is becoming increasingly the task of specialists in a field which showed a tendency to grow progressively narrower at the present time.

Water quality management involves two basic management principles: (1) planning, and (2) control or review and evaluation. The tools of such management include the science of planning through forecasting and research, standards of performance, controls, and appraisals. Time permits only a brief discussion of the more important of these. Planning is the determination of the proposed course of action for water quality control. It involves looking ahead in order to anticipate the possible difficulties and eliminate them if feasible. It includes a constant watch of future needs so that the present actions can be adjusted to meet these target objectives utilizing the advantages of improvement through research. Planning is the pre-determination of what should take place. It must be thought of in two major steps: (1) establishing a goal or objective, and (2) the selection of a system and procedures with the adoption of standards and criteria. Standards are merely operational yardsticks which express the result to be expected under certain conditions. They particularize on what conditions will prevail when performance has been met. Planning tells us what we are to do. Review, when properly accomplished, tells us just where we are. The link between review and planning could be called "feed-back." It is the transmission of intelligence to those making decisions so that the information can be an effective element in the next round of planning and action. Without feedback there is no point in carrying on a review.

Standards or criteria of quality are the foundations for building a successful water quality management program. They aid in defining the parameters necessary in interpreting the broad objectives. They are often the true parameters within which a program of water quality management successfully operates. Such standards are of practical importance for they form the technical and often the legal basis for any action to require conformance to an objective.

## Water Quality Management Objectives

The objective of a water quality management program stated in broad terms should be to secure and maintain available waters in such physical, chemical, and biological condition that these waters will not create a nuisance or be harmful, detrimental, or injurious to the public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate uses, or to livestock, wild animals, birds, fish, or aquatic life. To attain these broad objectives on a practical basis requires: (1) the utilization of a stream based upon its ability to assimilate wastes; (2) the consideration of the physical, chemical, biochemical, biological, and bacteriological conditions, in addition to the hydrologic factors in determining the quality of the water resource; (3) the recognition that no single standard of quality is applicable to all waters and, therefore, no single standard for the treatment of sewage or industrial wastes is applicable to all waste treatment problems; and (4) the recognition of the economics involved in the treatment of wastes consistent with the usage of the receiving stream.

## Water Use Determines Quality Necessary

All legitimate uses to which water is put must enter into the assessment of its quality. Such quality needs differ dependent upon usage. As an example, for domestic use water must be clear, clean, taste and odor free, relatively low mineral content, and free from disease-producing organisms and chemicals. Sources of domestic supply must be amenable to reasonable treatment to secure this quality. Agricultural uses require water primarily assessed upon its satisfactory mineral content, especially in respect to sodium and other cations and the presence of boron. Recreational waters must be relatively free from domestic and industrial wastes and be able to sustain aquatic organisms suitable for aquatic and wildlife food. Industrial water quality runs the gamut depending upon its requirement. Low mineral content and low temperatures are only two such requirements often necessary. The quality of water for power generation and navigation usually is less demanding.

## Present Methods for Determining Quality

Today, to measure the conformance to such quality needs, we have the old standbys of biochemical oxygen demand, the dissolved oxygen, chemical oxygen demand, chlorine demand, ammonia nitrogen, hydrogen ion concentration, color, turbidity, temperature, alkalinity (or acidity), hardness, chlorides, sulfates, and total dissolved solids. More recently a new one, radioactivity, has been added. Coliform organisms, plankton, and some organic chemicals must be included in any list today. While this appears to be quite an array of laboratory tools available to determine quality, unfortunately today all conditions which are altering our water quality cannot be measured by our present routine laboratory determinations. For many substances entering our streams, there are no known parameters and for some not even laboratory methods to determine their presence. Our present parameters are in general too meager and insufficient to cope with the increasing change of water quality resulting from our rapidly changing environment. Present laboratory means for determining compliance are in most instances giving us merely a history (incomplete as it is) of conditions that *did exist*, one, two or possibly five days previously. Methods are needed to determine what conditions are present *now* so that any hazards to a water's immediate use can be prevented. Analytical methods and parameters or standards for evaluating the results of such procedures must progress hand in hand. Our present parameters were developed before, for example, agricultural runoff contained fertilizer nutrients, herbicides, and pesticides, and before the modern age of science gave us the hundreds of organic and inorganic substances that are changing our environment. Through such application of science we are changing our environment and the quality of water available beyond the scope of present conventional means for measuring, and parameters for evaluating, these changes.

The field of chemistry alone is annually giving us some 400 new substances which are used for washing clothes, washing dishes, cleaning cars, killing weeds, and controlling insect pests, not to mention the long list of industrial and other uses. After these materials have served their intended purpose, the used substance and the wastes produced in almost all instances find their way into our watercourses through the waste collection system. Today we can merely hope that neither a single substance nor the combination of substances resulting from their mixing, for example, in a stream are toxic to aquatic life, animals or humans. I say only "hope" because in some instances we actually don't know. Adequate analytical methods do not exist to determine the quantitative presence of many of these substances. Thus, we do not have parameters for their evaluation. A recent toxicity study by a large industry of its wastes discharged to a watercourse could only conclude that during the eighteen-month test period, whatever the indeterminable substances that were discharged, they were not toxic. This is not a criticism of the industry, for such long-term toxicity studies by government or industry are exceedingly rare and this industry is to be commended for pioneering in such a vital study. It is mentioned here merely to illustrate the lack of up-to-date and necessary parameters for evaluating the quality of water for downstream uses. This might raise the question: where does the responsibility lie for determining whether the products of modern industrial development are toxic as discharged to a stream? The answer does not involve solely technical considerations. Is it the responsibility of government to prove the industry guilty or is it industry's responsibility to the public to predetermine and furnish adequate proof to the quality control agency that its discharge contains no substances which are toxic to aquatic, animal, or human life? Our system of free enterprise has and is producing many products valuable to our quality of living. Is it not industry's responsibility to assure that its wastes are not detrimentally affecting others? Admittedly, without up-to-date parameters and laboratory methods, the difficulty of discharging that responsibility by either government or industry at present is increased—if not made impossible in some instances.

## Need for New Parameters and Methods

There is a recognized need for the exploration of many of the blank spots on the water quality control map which not only involve but require a mutual appreciation by the public, industrialist, water supply technicians, and the politicians. All must adopt the habit of working together, of knowing each other's intellectual customs, recognizing and, above all, appreciating the significance of their colleague's viewpoint. This is another form of feed-back. Such cooperation in this field of water quality control is not a mere expression of sentiment but it is a national economic necessity.

Mention is made here only of those particular "blank spots" which pertain to parameters and the necessary techniques involved in their evaluation.

Improvement is necessary in some of our present parameters and methods as well as the introduction of new ones if we are to continue to properly evaluate the quality of water for its various legitimate uses and reuses. One illustrative example is cited.

We are still determining human safety and health protection of a water almost solely by the standards employing the coliform as its basis. Techniques for performing these bacteriological tests have been improved but the inadequacies inherent in the basis itself (the coliform organism) have been and are contributing to the obsolescence of this particular parameter. This disturbing fact has been recognized by water pollution control agencies who are required to use these parameters in determining whether a water is safe for human consumption. More chaotic still are the situations where standards applied to recreational waters utilize the coliform as the basis. There are no nationally accepted and recognized parameters using this bacteriological test for evaluating the safety of recreational waters for swimming and bathing purposes.

As an engineer interested in the practical application of laboratory methods to water quality management, it is sometimes puzzling to note that almost all of the research in water bacteriology and microbiology relates to coliform organisms. It would seem that more research time should be devoted to more significant and new organisms as a basis for judging water quality. It is true that a relatively small amount of work has been done on enterococcus as an indicator of potential human health hazards. However, some experiences have indicated its usefulness in evaluating pollution.

### Areas Needing Study

What are some of the areas needing further study and, in some instances, basic research? Needed improvement in the parameters of our present tools include the area of determining and evaluating the effect of detergents on our surface water, particularly in the reuse of the latter. This should include their effect upon the bacterial population, particularly the coliform group. Another area includes the effect and interpretation of the presence of sulphate-reducing anaerobes. Also, new parameters appear necessary to evaluate the significance of nitrifying bacteria as a possible indication of a stream's ability for self-purification and the assimilation of a greater pollutional load. Such studies should include the interfering effect to their usefulness and the inhibiting of their activity by the presence of new organics and metallic wastes such as chromium, to merely mention one. There is much need for study to improve the interpretation of direct microscopic observations of algae blooms, protoza, bottom fauna, debris, etc. This involves a greater practical use of aquatic biology as a tool in quality evaluation and prediction. There are possibly new parameters for the interpretation of actinomycetes (organisms found in natural waters and in waters containing wastes from biologic manufacturing process). Such study could possibly open new doors to determine, for example, if a stream's normal biologic balance was upset. Bacterial and animal toxicity investigations beyond our present parameters in those fields could conceivably produce new means of obtaining a more complete picture of water quality. All of the above suggested areas of study could result in the improved use of the laboratory tools that at present have some limitations in their application.

Another category of study and investigation would include basic research, in some instances, in areas that are not now normally included in the category of routine water quality laboratory investigations and evaluation. Briefly, this would include the field of bacteriophage and how it may be affecting the interpretation of our bacteriological analyses. The use of antigen antibodies with, for example, their reaction for serum and blood could conceivably be new tools for identifying the presence of specific pollutional wastes. Spectraphotometric curves on all known industrial wastes are needed. A wider availability for the use of identifying organic chemicals by carbon filtration, chromatography, and spectraphotometry should open new avenues for determining the presence and evaluation of these complex substances.

It is felt that one particular untouched area requires special mention. This concerns the presence of viruses in water. It is believed that in this area lies a whole new field of tools for water quality evaluation. For example, the present bacterial standards for safe drinking water are of little use in determining the presence of possibly potential hazardous viruses. We know, for example, that complete treatment of water will result in a supply safe for drinking judged by the coliform standard. However, the question has been raised whether these waters evaluated as safe based upon our present bacterial standards may possibly be responsible for otherwise unexplained outbreaks of illness because of the presence of certain viruses. It is believed that the application of the virus technology in the evaluation of water quality is particularly applicable at this time where water is to be reused.

Mention must be made of the need for increased study needed in the epidemiology of the environment, particularly as it involves water.

An important segment of water quality management involves the surveillance of streams through proper monitoring to determine how the waters are being used or misused. Mention of this increasingly important activity here is merely made inasmuch as the subject is treated more fully in other presentations on this program.

The robot monitoring program with its instantaneous determinations of water quality which has been inaugurated by the Ohio River Valley Water Sanitation Commission holds considerable promise for some of the solutions to the immediate determination of water quality conditions.

## Need for Integrated Control

Water quality management consists of making the wisest use of every drop of water to serve the multipurposes in the present and anticipated development of a particular area. This is a theoretical principle which we all accept; however, in practice we have not found effective ways to translate this principle into the efforts of the cities, industries, farmers, and the various State and Federal bureaus in developing and following a unified plan. For example, the opportunity and responsibility for reducing the waste of water use, and likewise the protection of its quality, is largely now with "local area managers." We do not have an integrated pattern of water quality management within many states nor in the Federal Government. Administrative responsibility if it exists is often divided. Certain legal rights, for example, in the withdrawal and use of ground water are undefined in many States. Some have little control over quality as well as quantity.

Interstate water quality control is not new to us. Sound attempts and results have been secured in a number of areas, notably in the Ohio River Valley through the effective efforts of the Ohio River Valley Water Sanitation Commission. The problems of water quality management are old but the magnitude of the problem has changed in such an order that it is almost a different kind of problem when viewed nationally. Reducing the wasting of water, preventing and abating the pollution of our water resources, increasing the efficient use and reuse, and intensifying our efforts to carry on needed surveys, come within the category of normal and essential problems. The fact that through our expanding industrial economy we have multiplied these problems by magnitude and intelligence does not change these facts. It will, however, require the application of a variety of professional, technical, legal, and political talents so as to develop a solid and sensible solution to some of the water quality management problems that are definitely on the horizon.

Unlike when our Nation was young, our rivers, lakes and streams must serve a veritable galaxy of purposes essential to our modern living. Too often in our own channels of narrow and biased thought we lose sight of their multipurpose use. Use that includes or could and must include an abundant source of protein food, transportation for commerce, aquatic recreation, sources of vital domestic water supply, irrigation for our crops, water for agriculture and animal use, power for the wheels of industry, a necessary raw material without which our industrial economy could not expand or even survive, and, yes, to absorb and transport from our very municipal doorsteps the waste products of a modern urban civilization. While the uses of our water resources are varied, if they are overused for one purpose they may be degraded for another. Too frequently we have attempted to establish water usages and water quality management on the basis of financial advantage alone.

## Conclusion

There are two requisites for doing a great and important work—a definite plan and a limited time. The time is already limited—we cannot continue to waste and defile the quality of so vital a resource as water. There is no time for any superficial solutions, neither is there a cheap and painless way to control or manage the quality of our water resources. We do have the know-how; patterns for administration can be resolved; we can and, in the competition for water, must pursue a sound, economical, and practical approach to assuring such a resource of quality suitable for our multipurpose uses. With our characteristic human nearsightedness we often look at our water resources as a "today commodity" whereas, because of our advancing years, we must take the farsighted look through the upper part of our aquatic bifocal view of this important resource. We cannot continue to look at water merely as a "present commodity," either in quantity or quality. In the matter of years this Nation is relatively young but we have reached maturity and are old beyond our years in regard to the use of our water resources. Many of our water quality problems are already old and it is our awareness of them that is new—the awakening awareness that to assure a supply of water adequate in quantity and satisfactory in quality for our anticipated domestic and industrial demands requires water reuse as a necessity—the awareness that reuse makes water quality management a necessity—a national necessity.

With our country's potential population and industrial growth predicted, it behooves all of us today to help translate this awareness into action—for "in today walks tomorrow."

**Dr. ACKERMAN.** Mr. Klassen, I think you have brought out in very clear fashion some of the more complex things that we have to deal with in reaching conclusions that this panel is expected to reach. I have often thought that if we used the standards of a hundred years ago—clean water—it would be simple, that is, we would not have much to do. But these standards not only seem strange to us today but actually abhorrent. Likewise, in the future, and perhaps the not too distant future, the next generation, for instance, may look back on our standards as being somewhat primitive. In other words, when we talk about cleaning our water in the not too distant future, we may be dealing with a far different thing than we are today, and I think Mr. Klassen has brought this out admirably.

# DISCUSSION

EARLE C. HUBBARD
***Secretary***
***North Carolina State Stream Sanitation Committee***

I am happy to have the privilege of discussing Mr. Klassen's paper on "Water Quality Management" and of bringing to your attention my concepts of some of the problems inherent in the management of the Nation's water resources. These problems are comprehensive in scope. They confront all levels of government as well as every individual citizen, and their ultimate solution will require cooperation on the part of all in the establishment and pursuit of sound objectives.

Mr. Klassen has performed an excellent service in presenting his much respected views on the various aspects of water quality management, including the necessity of such a program on a national scale. Having studied his paper at some length, I find myself in complete agreement with his views. Likewise, I find he has covered the pertinent aspects of the complex factors (social, political, legal, financial, and technical) which must be considered in the development of a well-balanced and rational water quality management program. My comments will, therefore, be concerned with either emphasizing points developed by him or with the presentation of new concepts which should be included in a discussion of the subject.

In the first place, we should consider why we need a water quality program. Is water suddenly a scarce commodity? Does a critical shortage exist, or is the problem simply one of imbalance between demand and usable supply, brought on by population and industrial growth coupled with unwise management?

Our records tell us that we are not actually exhausting the Nation's water supply. In terms of quantity, we have substantially the same amount of water as we have had since the beginning of mankind. The total supply, although quite variable from the standpoint of seasons and geographical regions, is quite constant. It is the demand and the manner of usage which are changing. We must admit, therefore, that we are not running out of water, but rather we are running out of time in which to establish and execute appropriate water management practices.

We must conserve and protect our water resources in order to survive. Water is unique in that it is absolutely essential to our very existence and yet mankind has not and is not likely to develop an acceptable substitute. Our survival and our growth potential are, therefore, dependent upon our ability and willingness to manage the available supply in such a manner that it will serve both the present and future requirements of the country.

A comprehensive water resource program entails considerations over and beyond those relating solely to quality; however, proper quality management, in the best public interest, necessitates an examination of all of the factors influencing available supply and demand. For instance, most uses of water affect in some way its quality and in turn, quality has a profound influence upon its suitability for a particular usage. We cannot solve the total water problem by attacking each facet separately. A coordinated program under which all parts of the whole will be considered is essential. Adequate quantity alone is not enough. It must be of usable quality. Therein lies the necessity for an effective water quality management program.

There are many varieties of pollutants which adversely affect the quality of our streams and each year many new substances are introduced as a result of the manufacture of new products. Many of these products are of such complex chemical nature that new parameters are needed in order to evaluate their effect upon the receiving stream. Likewise, presently known treatment methods are often ineffective in removing harmful characteristics. There is, therefore, need for developing new technology in the field of waste treatment and new parameters with which to judge the effects of these wastes upon downstream users. The development of these new tools in the science of stream sanitation is obviously necessary. Yet, the question of who should have the primary responsibility for providing this "know-how" inevitably arises. It would seem plausible that neither government nor industry should wait upon the other, but that both and all concerned should join in their efforts to develop solutions to new problems.

While there is an admitted need for expanding research efforts in the field of water quality management, I wish to emphasize the fact that existing technology in sewage and waste treatment is not being used to its fullest extent. The characteristics of most of our waste products, as well as their effects upon our waterways, are well understood. Methods of treatment are, likewise, available. The problem, therefore, is one of failure, for one reason or another, to fully employ existing intelligence in the field of pollution control. Certainly, little comfort can be derived from the knowledge that millions upon millions of gallons of raw sewage are presently being discharged into the Nation's waterways. Nor can this wanton practice be excused or brushed aside on the basis of lack of technology. We should continue searching for new, more efficient, and economical waste treatment methods; however, while this research is underway, we must stop deluding ourselves and actually put into practice treatment procedures already available to us.

The cost of water quality management, particularly as it relates to the construction and operation of waste treatment facilities, is of primary consideration. It is undoubtedly the greatest deterrent to adequate waste treatment confronting the Nation today. Many municipalities either are, or claim to be, incapable of financing required treatment facilities. Industries plead that their margins of profits are so slim the additional burden of waste treatment would result in bankruptcy. Such pleas are true in many instances but I suspect in a large majority of cases the financial capability, or lack of it, is not the real reason for their resistance to waste treatment. Nevertheless, the urgency and magnitude of the problem, as well as the need for some form of financial assistance to many municipalities and industries, must be recognized. Such recognition, whether in the form of grants, low interest rate loans or tax exemptions, will expedite pollution control measures, thereby benefiting the general public. The present sewage treatment works construction grant program under P.L. 660, although inadequate, has well demonstrated the efficacy of financial assistance in getting the job done. This program should be continued and enlarged.

Finally, we can no longer take pure water for granted. America has changed from an agricultural economy with small trading centers to an industrial economy with sprawling metropolitan areas. Wastes, in the form of used water, are being poured into our rivers in an ever increasing volume to flow downstream and adversely affect everyone living along their courses. At the same time, we are continually learning new ways of polluting these very same waters upon which we must depend to serve our growing needs, many of which are of conflicting nature.

The future of America lies in its ability to harness and properly manage its water resources. In many areas, we have already waited too long and done too little about pollution and we are suffering the consequences. Yes, as stated by Mr. Klassen, the problem of water quality management is old; it is only our awareness of its necessity that is new. The question is: Do we have the courage to translate this awareness into a coordinated action program under which all levels of governmental and private interests will assume and carry out their respective responsibilities? The cost will be high, but I am sure we can all agree that the prize will be well worth the price.

# Priorities for Water Use

HARVEY O. BANKS
***Director of Water Resources, State of California***

The preceding able discussion of water quality management has emphasized the magnitude of the growing competition for water. The demands of our surging economy and population for water for an ever-increasing multiplicity and complexity of uses present one of the major challenges of our time.

I question whether any informed person today would argue against the general necessity of pollution control. This is essential if we are even to maintain our available water supply at its present level of quantity and quality. But that is not enough today; the challenge we must meet is the need to increase the supply.

In a quantitative sense, our available supply of water is limited by the amount we can feasibly develop for use. Even with maximum possible degree of treatment and control of the disposal of human wastes, it seems clear that the available supply will be insufficient to meet all of the increasing demands upon it unless we can find some means of stretching the supply. This may depend upon our success in applying new concepts in establishing priorities for water use.

Priorities are not in themselves a new idea. They are probably man's most ancient solution to the problem of an under-supply of water; whether on a ship at sea or in the vast reaches of an empire. Instinctively, man recognizes elemental needs, and traditionally he has based his priorities upon those needs in the order of their necessity to life. First in order has come the quantity necessary for human consumption; second, the amount required for his domestic beasts; third, that required to raise food crops. "First things first" is a very old adage.

Very little precedent exists in history for establishing priorities on the basis of water quality considerations. Partly this is because water quality problems in the past have been largely local in nature, but the main reason may well be that until comparatively recent times the measurement of water quality could be made only on a very crude basis. If water was fit to drink, it was good enough for any use and the only tests for potability were empirical, based upon turbidity, odor, color, and taste. Fortunately, sources of pollution were relatively few when compared to present conditions. Natural mineral pollution was recognized; the Bible speaks of "bitter waters" that were undrinkable, and Hippocrates noted that waters coming from soil that contained iron, copper, sulphur, alum, or nitre were not good for drink.

Heavy organic pollution made water obviously objectionable to the senses of taste and smell—the degree of objection probably depending to some extent upon the cultural level of the prospective consumer. Some purifying methods, such as sand filtering, were employed at a very early date, and the Chinese are said to have employed ordinary alum or aluminum sulphate several thousand years ago as a coagulant to induce agglomeration of suspended particles in water and increase their density to the point of more rapid settling. By and large for centuries, if water did not offend the senses, it was considered usable for any purpose. Since bitter or smelly water would naturally be avoided, probably the most perilous source of pollution was by seepage from sewage wastes. Not until the discoveries of De Leeuw, Pasteur, Koch, and Lister was it known what dangers may lurk in clear, odorless water.

Today, we are living in a highly sophisticated society, and our needs for water have multiplied in number and in diversity of quality required to meet them. New uses for water are claiming an ever-increasing share of the available supply. At the same time, the older basic needs of man are demanding greater quantities of water, and water of a higher quality. Industrial expansion has intensified competition for water, as has also our population growth, at a rate undreamed of by our forefathers.

As our needs for water have proliferated, so have our sources and kinds of human wastes. Stream flow has been used since time immemorial as a means of waste removal. In the past, such wastes have consisted largely of domestic sewage, and the natural processes of dilution and biochemical oxidation provided a large measure of treatment. All indications point to the fact that this condition is rapidly disappearing. One reason is that the increasing demand for water is diminishing the amount of stream flow available for dilution of wastes. Another is that the character of waste is becoming more and more complex and contains an ever-increasing amount of material that cannot be readily treated by natural processes. Among these are detergents, insecticides, herbicides and other agricultural chemicals, and complex highly toxic materials that are long lived and not materially affected by sewage treatment. Radiological materials are creating waste disposal problems of an extent and nature not yet fully known.

As these waste materials increase in volume beyond the dilution capacities of waterways, a point is reached where the need of water for waste removal must be regarded as one of the major competitors for the available supply. It must be recognized that the inevitable wastes resulting from human activity, agricultural, domestic, urban, and industrial, must be disposed of and that by their very nature, final disposal of a major fraction of these wastes to surface and ground waters cannot be avoided. Likewise, it must be recognized that there are no known economical feasible methods of treating wastes to a degree or of so disposing of them that will not result in some deterioration of quality of the water resources to which the final product ultimately finds its way. Water quality problems encompass much more than public health or aesthetic considerations above.

At the same time, social values involved in water resources development and use are assuming a degree of importance comparable to that of the more traditional economic values with which, in the past, we have been principally concerned.

We have reached a point where any use of water that does not give optimum economic and social return is wasteful. To achieve optimum return, we must be frugal with the quality of water; we must expend its quality as a miser his coins, so that a given quantity of water can be used and reused as it moves down the ladder of quality degradation.

Justice Oliver Wendell Holmes once said, "Nature has but one judgment on wrong conduct—if you can call that a judgment which seemingly has no reference to conduct as such—the judgment of death. That is the judgment or consequence which follows uneconomical expenditure if carried far enough. If you waste too much food you starve; too much fuel, you freeze; too much nerve tissue, you collapse." [O. W. Holmes, Jr., address at Northwestern University, *Collected Legal Papers*, 272 (1920).]

That we must solve our water supply problems is plain; only the way remains to be found. Found it must be if we are to avoid nature's inexorable judgment on uneconomical expenditure continued too long.

Water rights doctrines and laws by which we have ordered our conflicting interests in the past appear to offer but little help toward solving our present supply problem. In general, many of our basic rules relating to water rights were evolved and enunciated as a part of the common law of England during the centuries between the Norman conquest and the American Revolution. The common law was judge-made law in that it was built up bit by bit by decisions stating the law as it existed by logical extension from statements in preceding decisions. Because cases presented to the judges in connection with land involved conflicts between private litigants almost exclusively, the common law was primarily concerned with private rights.

Land was extremely important in an agricultural economy and a feudal society such as existed in England during the great formative period of the common law. Feudal tenures by which land was held by individuals largely determined the social status of the holder, and possession of land was the source of wealth and power. Feudal incidents of land proprietorship were burdensome, however, and rights to the possession or fruits of land were determined upon the basis of highly technical and involved rules. Land, therefore, was a fruitful source of litigation, and the common law courts were land-oriented in their thinking.

With few statutes to guide them during the first six hundred or so years of their existence, the common law courts sought to make the law, as expressed in their own rulings, definite and certain in all things. This was especially true in doctrines relating to land law, because only by making the law certain could men know what their rights were. It is from this period that we received our common law water rights doctrines.

Water, unlike land, was plentiful in England and had little real value except as it served the land and its occupants. With minor exceptions, as in the case of navigible waters which were in a sense held to be public property like highways held in the king's name, water was considered as a part of the land. The common law, in order to reduce the vagrant substance to a form in which it could be subjected to definite rules, developed three conceptual compartments into which water in all the forms in which it is found on land could be fitted. Rules were then formulated through the years which could be applied to settle conflicts between private rights involving water.

A number of American States today still adhere to the old common law concepts of water, and the nature of rights that attach to it because of the ownership of land. The three old compartments still remain with us. Water flowing in known and defined channels is spoken of as streams, and riparian rights attach only to such water. Diffused waters (usually from precipitation or snowmelt) which have not yet joined a stream or sunk into the ground are called surface waters. These waters were too ephemeral to promote many rival claims to their ownerships, and the common law developed no particular rights that attached to them. Most disputes that did arise involved injuries to adjoining land, so the common law rules that developed concerned how to get rid of or protect oneself from surface water rather than how to hold on to it. Water that has permeated the soil is termed percolating water, and was considered by the common law to be a part of the land in the same sense as any other component of the land such as sand, rock, minerals, or soil. It belonged to the owner of the overlying land to the same extent as the other component parts of the land. The rights that attached to percolating water we know as overlying rights.

Riparian rights are not recognized in some of our Western states, but in most parts of our country much of the old common law concepts of water and the rights which attach to it because of its relationship to the land and thereby to the owner of the land remain a part of existing law. These rights have been modified in various ways, however, and there is an increasing trend toward public regulation of the use of water.

Riparian rights appear to have been the first to be modified to better meet the necessities of this country. The common law held that the riparian owner had an absolute right to use the water of a stream. pond, or lake to which his right attached for ordinary or primary purposes such as domestic purposes and consumption by his livestock. This was an unrestricted right; if necessary, he might dry up the stream for these primary uses. He had a more limited right to use the water for some other purposes, called extraordinary or secondary purposes, such as ponding it behind a dam to operate a mill or for irrigation, so long as the purposes were connected with or incidental to the use of the riparian land. He had no right to use the water for purposes unconnected with the land or to export it. [*McCartney* v. *Londonderry & Lough Swilly Ry.*, House of Lords, A.C. 301 (1904).]

Riparian uses of streams and lakes that adversely affect their purity and period of flow have been limited more sharply than have those which affect quantity of flow only. As a part of the natural flow concept, however, both freedom from material pollution and regularity of flow continue to be important rights of riparian landowners.

Riparian rights to the use of water attach to the land because of its position with respect to the source of the water. Such rights are not created by use or lost through disuse. With the development of the arid Western United States, it soon became apparent that the riparian doctrine could not be successfully applied there because of the limited water resources available, the need for large quantities of water for mining and for irrigation, and the obvious necessity to divert water from the few streams with adequate flow and transport that water for use on lands often far removed, sometimes hundreds of miles, from the source. Thus, the appropriative doctrine of water rights was formulated—"first in time, is first in right"—which is the controlling doctrine throughout the West although superimposed on the riparian doctrine in some instances, as in California. Appropriative rights are created through use and may be lost through disuse. Appropriative rights are administered pursuant to State laws.

Even under the appropriative doctrine, the traditional concepts of priority still apply to a very large extent. In the case of competing applications for the appropriation of a limited supply, domestic and municipal use are accorded the highest priority with irrigation ranking second in order. So far as is known, no appropriative rights have ever been granted for the use of water for waste disposal.

California, where it is necessary to transport huge quantities of water from the northern one-third of the State which has a large surplus of water over its needs, to Central and Southern California where the needs are far in excess of the local water resources, in the early 1930's established an areal priority to the use of water. The areas of origin, or surplus, which are developing slowly but inevitably, have been accorded by statute a first priority to the water needed for their future development as against the appropriation of water for export to the areas of deficiency where a highly developed economy has long since been established.

Industrial and municipal pollution began to present a major problem during the nineteenth century. The courts tended to treat this as an aspect of the law of nuisance, even where it unquestionably represented an unreasonable riparian use and, in some instances, a non-riparian use. This approach required that the riparian owner show an injury done to him as an individual different than that done the public in general. Since a public nuisance does not result in the acquisition of prescriptive rights to continue the wrongful use of property, many streams became heavily polluted before complaint was made. In many instances, such industrial or municipal pollution had assumed such importance in the economy of the locality that the courts, balancing the hardships for and against preventive relief, have relegated a downstream or lakeshore riparian owner to a recovery of damages and refused to enjoin the continued pollution. In one instance, for example, a State court refused even to award damages to a lower riparian owner for pollution incidental to a coal mining operation. The riparian owner had formerly used the stream water for a fish and ice pond and a house cistern. The court expressed its attitude by saying:

> It has been stated that 30,000,000 tons of anthracite and 70,000,000 tons of bituminous coal are annually produced in Pennsylvania. * * * If the responsibility of the operator of a mine is extended to injuries of the character complained of, the consequences must be that mining cannot be conducted except by the general consent of all parties affected. [*Pennsylvania Coal Co.* v. *Sanderson*, 113 Pa. 126. 6 Att. 453 (1886).]

Relatively few courts, of course, have permitted the necessities of an industry to eliminate, without compensation, the riparian rights of individual owners. So serious, however, did stream pollution become as a result of inaction by riparian proprietors that the legislators of almost every State found it necessary to control by statute the pollution of rivers and streams.

Control of pollution in interstate rivers and lakes is now made possible by interstate agreements pursuant to the Federal Water Pollution Control Act of 1948. [62 Stat. 1155, 33 U.S.C. Sec. 466.]

It is interesting to note that England, the home of the common law, passed the Rivers Pollution Act in 1876, and even before that exercised jurisdiction over rivers through officers of the Crown, such as commissioners of sewers, under the Crown Land Act of 1866.

Litigation involving conflicting rights to the use of percolating water was late in reaching the courts. The common law rule was first announced in an English case in 1843. [*Acton* v. *Blundell*, 12 Mees. & W. 324, 152 Eng. Rep. 1223, 15 Mor. Min. Rep. 168 (1843).] That rule, as I have mentioned, was that rights in percolating water were regarded as belonging to the owner of the freehold, as the other substances found in the land. It was further ruled that the owner might intercept, impede, and appropriate such water while it was upon or beneath his premises, regardless of the fact that his use might cut off the flow of the ground water to adjoining land and deprive the adjoining landowner of its use. At an early day, our courts showed dissatisfaction with the English or common law rule and began applying what they called, variously, the rule of reasonable use or correlative rights. Briefly, this rule restricted each landowner to a reasonable exercise of his own rights and a reasonable use of his own property in view of the similar rights of others. The rule of reasonable use is now widely followed in this country, even in States which at first adopted the strict common law rule. [*Meeker* v. *City of South Orange*, 77 N.J.L. 623, 74 Att. 379, (1909).]

Conflicting rights affecting pollution of percolating water do not appear to have resulted in litigation until well into the nineteenth century. Pollution of a well by throwing into it the carcass of a dead animal is said to have been an indictable offense at common law, [*State* v. *Buckman*, 8 N.H. 203, 29 Am. Doc. 646 (1836).] and putting poison in a spring or well was also early made a criminal offense.

In England, by 1867, it was established that unreasonable pollution of percolating water would be restrained even though the use which caused the pollution was otherwise lawful. [*Turner* v. *Mirfield*, 34 Beav. 390, 55 Eng. Rep. 685 (1865); *Womersley* v. *Church*, 17 L.T.N.S. (Eng.) 190 (1867).] The American courts tended to regard such pollution as in the category of a private nuisance and to apply the doctrine of balancing the hardships that had contributed so greatly to the pollution of our rivers. In other American jurisdictions, liability of the person causing the pollution was held to depend upon the question of negligence. As the oil industry grew, many States adopted statutes to assure landowners of compensation for pollution resulting from drilling activities, regardless of any negligence. This has protected private property rights to some extent, of course, but has not prevented the degradation of ground water by oil seepage or invasion by saline water.

Thus, our courts have moved through stages of development or progress within the framework of the protection given private rights by the common law. Public rights have been recognized, but this has principally been done under the balancing of the hardships doctrine, and, while it may have cut into the common law rights of landowners, it has been rather more promotive of pollution than protective of our water supply.

The common law can be abrogated or modified most effectively by statutory law. In England, where Parliament enacts statutes applicable to the entire realm without limitation, the problems of water pollution could perhaps be more easily solved on a national basis than in this country with its 50 separate States. The whole power of the Crown was vested in the people of this country after the American Revolution; some of that power has been delegated to the Federal Government, but a great deal is reserved to the people and their State governments. If this country, then, is to solve its water demand problem and institute effective qualitative priorities so that by pollution control our available supply of water can be increased, greater recognition of the problem and the necessity of solving it is necessary at every governmental level.

Although there is no well-established body of law for priority of water for waste disposal, there have been other approaches to this problem through the adoption of water pollution control regulations. Systems have been established for stream classification or zoning, giving consideration to the various uses to which water may be put and deciding what constitutes the best usage of the watercourse in question from a quality standpoint. Waste disposal is then controlled to maintain necessary water quality conditions required for this usage. In California, the "case-by-case" method is utilized, in which method waste discharge requirements are established by water pollution control boards on an individual basis for each separate waste discharge and for each particular point of disposal. Under the statutes, due consideration is to be given to all aspects of water development, including water uses, waste assimilation capacity, waste disposal needs, and other needs.

At this point, I would like to quote from a paper entitled "Benefit Optimization in Water Resources Management, The 1960's and Beyond", given by Irving K. Fox, Resources for the Future, before the Interstate Conference on Water Problems on December 6, 1960.

> ### *Water Development and Management in American Society: Past and Present*
>
> There are three concepts of the role of water development and management in American social and economic life that have had a profound influence on water resources policy. These are what I will call
>
> 1. the "key to development" concept
> 2. the "yardstick and birch rod concept, and
> 3. the "staff of life" concept.

*Key to Development*

Through much of our history water development has been looked upon as the means through which an area or region could achieve economic development. It was this conception the first spurred the public improvement of inland waterways in the 19th century. Navigation facilities would open up what was then the West, permit the economies of the Western states to expand and, through trade with Eastern and foreign markets, support the growth of seaboard cities. The Erie Canal and New York City are monuments to the validity of this belief.

Beginning in the 1870's, irrigation was viewed as the key to development of the arid and semi-arid Western states. Irrigation is essential to agriculture in this region. Agriculture would support centers of trade and these in turn would lead to the establishment of manufacturing and other activities. Any of us acquainted with the West know many instances where this vision became a reality.

From the time of first settlement of the Mississippi Valley, control of floods has been seen as the key to economic utilization of the rich lands of the valley for agricultural and other purposes. As control has advanced the lands have been developed and both agriculture and industry have expanded.

These * * * examples are sufficient to remind you of the extent to which historically we have looked to public water development as a key to economic development generally, as well as to economic stability.

*Yardstick and Birch Rod*

Although the "key to development" concept tended to dominate thinking about Federal water policy through the 19th century, in the latter part of that century it was joined by what I am calling the "yardstick and birch rod" concept. Although this phrase was not prominently used until the 1930's, the essence of the concept can be traced back to the report of the Windom Committee to the Senate in 1874. That historic report proposed a comprehensive national scheme of improvement of navigable waterways and the construction of canals—not just in the interest of development—but also as a means of regulating railway rates and services indirectly through the competition of alternative transportation facilities.[1] The report reflects the belief that direct governmental regulation, as has been attempted through the Interstate Commerce Commission since 1887, could not be successful. Even the Senate report which subsequently recommended creation of the ICC stated the opinion that water routes were "the most efficient cheapeners and regulators of railway charges."

This "yardstick and birch rod" concept had its beginning in the field of electric power in a law of the state of Massachusetts enacted in 1891. It was in that year that Massachusetts came to have—as a result of the persistence of the town of Danvers—the two pronged policy that has come to be basic in both State and federal electric power policy: direct regulation of private utility service and rates, and also indirect regulation through establishment of the right of a municipality, to provide electrical service for itself and its citizens.

At the Federal level, efforts to establish the "yardstick and birch rod" concept as public policy culminated in TVA, the REA program, and the inclusion of the "preference clause" in Federal legislation establishing policy for the marketing at wholesale of power produced at Federal multiple-purpose water resources projects. This line of Federal legislation, by helping to support in turn some 3000 municipalities, public power districts, and rural cooperatives through the United States, applied on a wide scale the concept that regulation of private utilities should be undertaken through the competition of publicly sponsored institutions.

---

[1] The report also recommended that a two track railroad line from the Atlantic Coast to the Mississippi for carrying bulk freight be constructed and operated by the Federal government as another means to the same regulative end. The political force of this concept was very strong in the last half of the 19th century and is still held to be valid by some in railroad regulation today.

There are many important facets to the complex history of the development and administration of Federal and State electric power policy. Obviously I cannot attempt a complete appraisal here. But one can say this: a fundamental consideration underlying Federal power policy is the concept of using federally produced hydroelectric power to provide *competition* to the private power industry and thus stimulate lower rates and higher standards of service. In spite of all the heat that has been generated over this concept, and all the complex factors that must be weighed in its fair appraisal, I believe that history has demonstrated the utility of this concept and that in areas where there has been public competition lower rates and improved service have resulted.

### *Staff of Life*

The third concept which has had a profound influence on water resources policy is what I have called the "staff of life" concept. It embraces the idea that since water has a value that extends well beyond its economic worth, economic criteria and economic considerations are not suitable indicators of the scale of development warranted. Four manifestations of this concept will indicate what I mean.

The first of these is the widely held view that every drop of water that falls upon the land should be put to fully productive use on its trip back to the sea. Failure to do so is to indulge in waste. From this idea appears to come the view that we should aim at "full" regulation of the nation's streams and "maximum" physical development of each dam site. Economic considerations, so it is held, should not preclude the realization of these objectives.

A second manifestation of the "staff of life" concept is the view that hydroelectric power should be developed fully to save other kinds of fuel, particularly the fossil fuels. Back at the turn of the century when the demand for energy was increasing rapidly, it was accepted that the mineral fuels would eventually be exhausted and man would be completely dependent upon wood and hydroelectric power as a source of energy. The maximum physical production of hydro was believed to be essential to the conservation of the known mineral fuels to provide "the greatest good, for the greatest number, for the longest time."

A third element of the "staff of life" concept is that since clean water is essential to sanitation, public health and the control of fires, large quantities of good water should be available regardless of cost or of "the ability to pay" of those directly benefitting. Again water development was not to be determined by economic considerations.

Fourth, the "staff of life" concept has provided support for reclamation, flood control, and watershed management programs. Here the theory has been that since every acre of land will eventually be needed to support life, the bringing of land into production through such programs is intrinsically good regardless of cost.

### *The Impact of the Post-War Years*

There are other concepts which have helped shape national water policy in the United States, but the three I've described have been of unusual importance. Moreover, they remain as potent influences on water development in this country. But should they? At one time most elements of these concepts were valid. But are they suited to the kind of society and the kind of economy we have today and will have in the future? It is my thesis that these concepts look to the past and not to the future, to American society as it was, not as it is and is destined to be.

First, for a variety of reasons I cannot believe that the concept of water development as a "key to development" is appropriate any longer. As a means of stimulating economic activity water development alone generally influences such a small component of the total economy of a region today that such development does not have the impact it did in earlier years.

The arid and semi-arid West is confronted with a different situation. As essential as water is to the arid and semi-arid regions of the country, there is little basis for arguing that water development is needed to stimulate economic growth in this region. Between 1940 and 1960 the population of the eleven Western States (exclusive of Hawaii and Alaska) increased by 92 percent in comparison with a 29-percent increase for the Nation as a whole. If California is excluded from these figures, the increase for the West is 69 percent in comparison with 29 percent for the Nation. In the face of this growth per capita income levels have remained relatively high. The West has found that its climate, its scenery, and its space are among its principal resources. As I've said on previous occasions, for much of the West, the major task of water management is to accommodate the growth destined to occur instead of to stimulate additional economic activity through water development.

The validity of the "yardstick and birch rod" concept in the field of water development is open to serious question in view of the nature of the modern transportation and power industries. With transportation facilities as widespread and diverse as they now are, does publicly developed and subsidized navigation facilities serve effectively to help regulate rates and standards of service? I doubt it.

Also I doubt that public development and marketing of hydro is any longer an effective means of aiding regulation of the power industry. I'm not arguing against public development and marketing of hydro nor do I contend that the power industry should not be regulated. My point is that since hydro can supply such a small portion of the enormous power loads of the present and the future and since in almost every area the greatest value of hydro is for peaking purposes, public development and marketing of hydro fails to function as an effective regulatory device. Yet, in my judgment, the public-private power controversy—which has centered largely on hydro—and the failure to reach agreement on alternate means of regulating the power industry, has been a major barrier to the improvement of water resources policy in the United States.

Several considerations give rise to serious doubts about the validity of the "staff of life" concept. Two factors—scientific advance and an enormous increase in widely enjoyed living standards—have undermined the foundations of this belief. In view of the breakthrough of atomic energy and the enormous energy demands of our modern economy, should the fossil fuel supply be an important consideration in the development of hydro? In view of the rate of scientific advancement and the flexibility that science promises for balancing the supply of and demand for water, should reservoir storage be provided for which there is no visible need? In view of continuing improvements in agricultural productivity that science is making possible, is there a logical reason for bringing land into production for which there is no foreseeable economic justification? In view of the level of income that practically all Americans now enjoy, is there a sound basis for believing that in order to protect public health and safety clean water must be a practically free good? I doubt that any of these questions warrant affirmative answers in the 1960's and beyond.

In short, I do not believe that we can continue to look to water management as a key to development, as an aid to utility regulation, or as a resource which warrants public investment beyond that justified by clearly identifiable values. New concepts are needed to guide us in determining the kind of water development and management best suited to optimize benefits from the Nation's water resources. Let us turn to the nature of the problem of benefit optimization today and in the future.

Against this legal and institutional background, where do we stand at present and what of the future?

To reiterate, the demands on the nation's water resources are rapidly increasing, in magnitude, in diversity, in complexity and in scope—the rate of increase will undoubtedly accelerate in the future rather than diminish; for instance, supplemental irrigation is rapidly expanding in the humid areas. Many of these demands are competitive and conflicting among themselves, such as water for fish and wildlife resources vs. water for disposal of wastes. Changes in water use are occurring such as the shift from irrigation to municipal and industrial use, as in Southern California. The pressures on our water resources are not only economic but also social as in the case of the demand for water-associated recreation and for the enhancement of fish and wildlife resources.

At the same time, new sources of energy are becoming available and new means of transportation so that use of water for these purposes is no longer comparatively so significant. There is some considerable reason to hope that new sources of water, such as saline-water conversion and augmentation of our fresh water resources by weather modification, may be in the offing. Much can be accomplished by increasing the efficiency of use of water and in its reuse.

We are now concerned with water as a scarce—and vital—resource rather than as a "free good" which has, to a large extent, been the traditional popular attitude towards water. Even scarcer in the future will be the money which will be required to develop the basic resource and make it available for use when and where needed. We must insure that we obtain the maximum economic and social return for the dollars we have to spend

In planning for water development in the future, *all* of the economic and social demands, both present and future, on the particular water resource concerned must be taken into consideration. The objective must be the achievement of optimum, long-range economic and social benefit to meet the multiplicity of needs of people for water. To accomplish this, requires some changes in our thinking as to the proper future priorities for water use.

In certain instances, greater benefit may be achieved by giving priority to water for fish and wildlife as against its use for irrigation or power generation or navigation. In other cases, use of a particular reach of a stream primarily for waste disposal may yield a greater return than maintaining the quality for the so-called higher uses. Use of water for industrial purposes may, where water is extremely scarce, as in the Southwest, be of greater value than stimulating agricultural development and dedicating the available water supply to that use. Each situation must be judged on its own merits.

As technology continues to develop and as the Nation's economy expands in pace with population growth, waste disposal will become increasingly critical. This is dramatically shown in the results of the study reported in Committee Print No. 29 of the Senate Select Committee on National Water Resources. The economics of waste disposal will be of ever greater significance to municipalities and industries. Larger quantities of water in streams and in ground water basins will be necessary to provide for dilution of wastes resulting from agricultural, urban, and industrial development. The need to provide water from storage works to be constructed under Federal programs for dilution purposes or for low flow augmentation has been recognized by the Congress.

Water rights aspects of water quality and waste disposal have not been clearly determined by our courts or by statute. It appears inevitable that as water quality deteriorates and interferes with established uses of water, litigation regarding water quality will increase in frequency and magnitude; therefore, water quality rights will, of course, achieve greater recognition and more precise definition. Adjudication of water quality rights may hinge upon resolution of such factors as natural water quality conditions and fluctuations, water quality requirements, identification of sources of degradation and the influence of each, chronology of water utilization and waste disposal, and relative benefits of waste disposal and water quality maintenance for other uses.

Water rights litigation, like all litigation, is expensive and may develop into a long drawn-out series of hearings in various courts. Indeed, experience indicates that such prolongations are more likely to ensue in water rights litigation than in other matters.

To some extent, at least, the waste-disposal problem could be mitigated by proper zoning for future urban and industrial developments. This possibility has not been explored to date to any significant degree.

In any event, it seems clear that we must develop and accept new concepts as to the establishment of proper priorities for water use with waste disposal taking its proper place among the necessary uses of water as well as water for recreation and for fish and wildlife resources, in the competition with water for municipal, industrial, and agricultural purposes. We must also accept the fact that priorities of use for a particular water resource may well change with time. We must also face up to the necessity of making more efficient use of our water resources supplies. Reuse of water must be achieved to the maximum feasible extent.

The task of maintaining the quality of the Nation's water resources at the requisite levels to satisfy all the competing and conflicting demands thereon will be increasingly difficult and expensive. A comprehensive long-range water quality and waste-disposal plan is essential for establishing qualitative water use and waste-disposal priorities; we are accustomed to think in terms of long-range planning from a quantity standpoint but little has been done as regards quality. Such a water quality plan should take into consideration present and future conditions with respect to water development, waste disposal, and qualitative needs of all water uses to be made. It should be prepared in conjunction with statewide water development planning and, if possible, nationwide planning. It should take into consideration the quantities, characteristics, and points of disposal of wastes, the stream flows that will be available for waste dilution in the future, and the waste assimulation capacity of those flows. It should establish water quality objectives at various strategic points suitable for water uses contemplated under water development plans. It should evaluate the estimated quality of water, taking into consideration both waste disposal and water use, and determine what water quality objectives can and should be met for each reach.

The objective of such a long-range plan should be the establishment of qualitative priorities for water use to the end that pollution control may be an effective means of increasing our available water supply and that our water resources may be utilized in a manner that will result in the maximum benefit to the people of our Nation and our States. Quality deterioration, per se, is not necessarily bad—the question is, in any particular case, to what extent should deterioration be allowed for optimum benefit.

In conclusion, I should like to emphasize that (1) the traditional ideas concerning water development are no longer valid—new concepts are needed; (2) generalizations are meaningless as regards water use or priorities—each water resource or each reach of a stream must be analyzed separately in relation to the needs of the basin or region through which it flows; (3) water pollution control cannot be treated separately from the other aspects of water resource development, management, and use as we so often try to do; (4) in the future, the need for water for waste disposal must be fully recognized and provided for; (5) in the management and further development of our water resources, optimum economic and social benefit in relation to cost must be the objective—no single or arbitrary system of priorities of water use will meet this criterion, rather each situation must be analyzed on its merits; (6) long-range, comprehensive regional planning for water quality management and for waste disposal is necessary if we are to maintain the quality of the Nation's water resources at adequate levels; and (7) the present uncertainty as to water quality rights must be resolved. Increasing priority must be given to those projects and those water uses which contribute to the gross national product.

Recognition of the expansive potential of a water supply in a qualitative sense and establishment of valid criteria for quality priorities might well stimulate new industrial growth in areas which now face economic stagnation. The exploitation of our water resources to their full extent has but begun and presents a tremendously exciting field for our legislators as well as for economists, planners, and engineers.

**Dr. ACKERMAN.** Thank you, Mr. Banks. You have introduced us, or at least mentioned for the first time this morning, a subject which I expect to hear more about in the course of the afternoon and which I think really is one of the important ones to be dealt with by this panel, that is, the matter of comprehensive development, a development which aims at the maximum benefits for all purposes. You have mentioned an interesting standard for judging that, that is, increase in the gross national product. That is one we might very well think about. I think you have noted effectively also that the legal structure is important in achieving comprehensive development, if indeed we agree that that is the objective, and that legal structure may or may not be compatible at the present time with the needs of the future for establishing comprehensive development.

You have also introduced us, I think, to the conception of water quality rights. Of course, we have long had, as you noted, water quantity rights, but perhaps water quality rights are at least coequal with water quantity rights and we should see to their establishment in the future. I think that is a point which might very well be discussed later.

## DISCUSSION

### Hon. FRED G. AANDAHL

***Assistant Secretary of the Interior***

The subject, "Priorities for Water Use," presented by Mr. Harvey O. Banks, is most challenging. An historical analysis such as he has made of the development of priorities as they exist today is essential to planning for the future. The growth of appropriative and riparian water rights through the years, influenced by the actions of the courts, the Congress, the Federal executive agencies, the States, and the lesser political units, has established a background upon which our new planning must be based. In other words, we are not at liberty to proceed freely with the idealistic as we may view it from the vantage point of 340 years of American experience. Our purpose must be to remodel what we now have so that it will provide adequately for the future. This must be done with the least possible harm to the beneficial uses built around the priorities already established. The total of the past as it makes the composite of the present is the heritage from which we now must work.

All through the years, the competitive struggle for the use of water has been the subject of much turmoil and litigation. These words of caution are not intended to discourage aggressive action but rather to steer our approach to an essential sound footing. It is my purpose in brief discussion to suggest Mr. Banks' excellent presentation as a springboard for action.

Concerted action in an expanded local area, aided by State and Federal agencies when appropriate, to find an answer to an aggravating community water problem is perhaps the only way to make effective adjustments in established priorities. The assembly of adequate basic data is the first step. Again, we cannot ignore what has been established. We must review the present uses and look for means of improvement. The elimination of waste, the reduction of pollution, the redetermination of the basic purpose of the stream or its bed, and the development of new sources of supply are all subject to consideration.

The Department of the Interior has been particularly active in the elimination of wasteful uses of water and in the development of new sources of supply.

The reduction of nonbeneficial consumptive use of water has taken the form of lining canals, elimination of phreatophytes, reduction in reservoir evaporation, and the nonexcessive use of irrigation water in the production of crops. These factors all affect the supply that is subject to a priorities evaluation.

In the development of new sources of water supply, the Department of the Interior is gaging streams, researching ground water, building dams with sizable storage reservoirs, and making remarkable progress in developing or aiding in the development of ways and means of converting sea and brackish water to fresh water at a price low enough to be within the reach of many users.

This limited, specific reference to the Department of the Interior is intended to be only illustrative of the activities and interest of the Federal Government in our water resources. The Departments of Health, Education, and Welfare, the Army, Agriculture, and Justice all are deeply concerned about water use and its priorities.

While many communities are short of usable water because of time or place or quality, it is correct to say we still have a tremendous potential water resource waiting in its development only for the ingenuity and aggressiveness of the American people and their rapidly growing population. For high success there must be involved in such action a combination as might be relevant of wide community interest, the urgent needs of private enterprises, and appropriate constructive action at every governmental level. In plain words this means community planning stimulated by State and Federal interest within the framework of acceptable procedures.

In its report to President Eisenhower, dated December 22, 1955, the Presidential Advisory Committee on Water Resources Policy stated, "The Committee is convinced that no statement of relative priorities for the use of water can be made which is applicable to the entire country.

"As pointed out, most of the 17 Western States, under the doctrine of appropriation, have adopted certain priorities of uses, usually in the order of (1) domestic uses, (2) stock watering, (3) irrigation, and (4) manufacturing of hydroelectric power. Such a pattern is obviously not applicable in many of the Eastern States, where the major problems are (1) domestic use, (2) industrial use, (3) water pollution, and (4) navigation." It should be noted that domestic use includes municipal use.

Prior to the last four or five decades the development of water resources was planned largely on a single purpose, single project, single agency basis. Around such single-purpose thinking priority uses and priority rights have been established. To the extent that a changing economy or a changing population pattern may make it advisable to consider modifications in such priorities, just compensation will generally need to be made.

As we proceed with these further studies for establishing priorities, particular attention needs to be given to the accelerated nationwide interest in recent years in fish, wildlife, and recreational purposes.

In the most part, up to the present time, our thinking has been directed year by year to the establishment of priorities for the use of newly developed sources of water supply. More and more, however, this process must be associated with adjustments in uses and priorities of the earlier supplies. In planning, both the new and the old, either separately or together as the case may be, should be geared for the new environment of the future. Each new use recognized and each adjustment made in former uses become a part of the process by which firm priorities are established.

In conclusion, it is apparent that the establishment of priorities for newly developed sources of water supply and also any adjustments that might be made in established priorities will be of a multipurpose nature. This means that many agencies, Federal, State, and local, will be vitally involved. While the order of priorities will vary in the different areas of the country, the approach to the solution can be substantially the same everywhere. Joint planning based upon adequate, current, basic data is essential. It is certain that in these studies the advantages of pollution control as a means of increasing the consumptive use of the water supplies will be apparent. The priorities of use that will be given to the supplies of water that are available will vary from community to community depending on the density of the population and the urgency of the needs for each of the several purposes.

**Dr. ACKERMAN.** Thank you, Governor Aandahl. You have brought out, I think, some additional points which are worth emphasizing. One is the importance of beginning or at least considering in a very significant and outstanding way the needs of the communities and their place in this planning. We sometimes think of plans as starting on a much broader or regional basis rather than with the communities. But I would agree that the communities are an essential and extremely important part of the process of planning for water.

You have brought out, also, that no statement on water use can be applied perhaps not only to the entire country, but it is difficult to make a general statement on water use even for a region. These are points again which I think we may well keep in mind in arriving at our conclusions in our succeeding discussion.

## Panel II

### General Discussion

**Mr. LAWRENCE.** This question addressed to Mr. Hubbard was asked by Mr. W. Wayne Campbell, of the United States Steel Corp.: ***"Is it practical to attempt to control pollution by adoption of uniform national standards of water quality?"***

**Mr. HUBBARD.** Water quality varies from State to State, from area to area, and I rather doubt that firm uniform water quality standards applicable to the country as a whole would be practical. I think uniform water quality standards as a guide might well be worth considering, but I don't believe that the standards that we demand and need in North Carolina would necessarily be those that would be applicable or desirable for some other sections of the country.

**Mr. LAWRENCE.** Here is another question for Mr. Hubbard asked by Mr. John J. Meehan, Chamber of Commerce of the United States: ***"I suspect in the large majority of cases the financial capability or lack of it is not the real reason for municipalities and industries resisting waste treatment. Yet you state: 'Need for financial assistance for cities and industries must be recognized.' How do you arrive at this latter conclusion?"***

**Mr. HUBBARD.** I think my first statement was that I suspected that in all cases, in many cases particularly, the lack or so-called lack of financial capability was not the real reason. I think the lack of awareness of the need of it and the lack of desire to capitalize necessary treatment are still perhaps major factors in our failure to move forward with waste treatment as rapidly as we need.

I also said that I felt that in some instances municipalities and industries should have recognition in the form of some type of financial assistance in the matter of waste treatment. Actually, the feeling exists that, after all, this matter of waste treatment does not necessarily improve the water supply situation for the particular industry or municipality expending the funds for waste treatment, but rather that it improves the situation in terms of water supply for downstream users. Also, recognition must be given to the fact that we cannot confine the effects of pollution in a county, State, or region.

I think that it is well that some sort of government financial recognition be given to efforts being made by our municipalities and industries, and I would like to say in this connection that tremendous efforts are now being made in our State of North Carolina by both industries and municipalities. I have no fuss with those industries and municipalities which are moving forward with their program. We still have industries and municipalities, though, that for one reason or another are not taking the steps that they should, and I think we had better quit deluding ourselves and get down to the business of pollution abatement, utilizing the knowledge of waste treatment that we have in doing a job that we all admit and know we must do if we are to survive.

**Mr. LAWRENCE.** This question for Mr. Hubbard was asked by Mr. Leon W. Dupuy, United States Bureau of Mines: ***"You have emphasized pollutants and substances put into water but did not mention temperature. Since great quantities of water are used for cooling, is not temperature a major pollutant?"***

**Mr. HUBBARD.** I simply must agree that increased temperature to the point that it interferes with necessary downstream water usage is certainly a form of pollution that is important and should be abated. I use the word "pollution," probably influenced by the fact that our State statute specifies that pollution of water is any change of its nature which tends to interfere with its usability. I should certainly think that increased temperature would be rightfully classified as a pollution or as a pollutant.

**Mr. LAWRENCE.** This question is directed to Mr. Banks by Mr. Wallace West, of the American Petroleum Institute: ***"You have spoken of water as if it were the only way to dispose of wastes. Is any research of importance being done on more modern disposal methods, that is, smogless incineration, large-scale dehydration, and burial, and so forth? Can such things alleviate the pollution problem substantially?"***

**Mr. BANKS.** If I said that disposal of water is the only way to dispose of wastes, I am sorry. I did not mean to imply that it is the only way. It is not. What I did intend to say and perhaps did not make clear is that a major fraction of our waste products do find their way into watercourses.

Now, with respect to other means of disposal, yes, there is a considerable amount of research being conducted in that regard. There is disposal through deep wells, reaching into salt water or unusable water. There is research on radioactive waste disposal, and saline water disposal from oil wells. New methods are being found, but I would venture the opinion that even as in the long range picture, a sizable fraction of our total waste, will and must continue to find its way into our water resources, either ground or surface or both, as the case may be.

**Mr. LAWRENCE.** This question is directed to Mr. Klassen by Mr. Louis F. Clapper, of the National Wildlife Federation: ***"Mr. Klassen infers that industry has a basic responsibility for assuring its wastes are not detrimentally affecting others. Does he not believe that this concept, which well could be a part of the goals of this Conference, should be expanded to say that all users of public waters have the responsibility of returning them at least as free of wastes as when they were taken? This philosophy, of course, recognizes that certain technical problems remain to be solved."***

**Mr. KLASSEN.** It sounds like the person that prepared the question had an opportunity to read the complete published version of this paper, because I believe that is what I inferred. As a matter of fact, I believe I came very close to saying those very words.

My own personal belief is that industry has the responsibility to assure the water pollution control agency, we will say in this case, that it is not discharging waste into a stream that would be detrimental. I think that it is their responsibility and it is not the responsibility of the control agency to have to prove to that industry that what they are discharging into there is detrimental. I think that is a basic industrial responsibility, and I certainly agree with the person that asked the question that the water should be returned to the stream by an industry at least of the same desirable quality that it was when it was removed.

**Mr. LAWRENCE.** Thank you, Mr. Klassen.

This question is also directed to Mr. Klassen by Mr. Grant A. Pettit, of the Armco Steel Corp.: ***"In view of the fundamental concept that a beneficial use of streams is to carry away wastes, should treatment of these wastes be provided beyond that necessary to protect these established users?"***

**Mr. KLASSEN.** No, I don't think that we in our economy must require wastes to be treated beyond the point at which the stream will absorb those wastes. I know that a little different interpretation of this concept was enunciated by Mr. Hollis yesterday. My own concept of this industrial question is not how much should we make industry do but how little is necessary for industry to do in the way of waste treatment and still maintain the water in the outlet stream for the legitimate uses of that stream below that outlet.

This, of course, brings up the whole question of classification of streams, which we don't adhere to or believe in in Illinois. I personally feel that each industrial or municipal problem so far as it involves degree of treatment is based upon the use of the stream below that outlet, which, of course, also takes into account the dilution factor. To have any other concept; namely, treatment merely for treatment's sake, is contrary to our particular type of economy, free enterprise, and from a practical standpoint in this country.

**Mr. LAWRENCE.** This question is from Mr. R. J. Faust, Executive Secretary of the American Water Works Association. It is in two parts:

***"Part 1: Why permit the unusual contaminants to enter a stream? For example, an unusual industrial chemical which has a limited use at a small number of places. Part 2: Why not reuse of industrial water by the industry producing the waste?"***

**Mr. KLASSEN.** Most of these questions seem to be pointed at industry. They are not necessarily the big bad boys, and the ones that are creating all the pollution problems. They do create problems. However, municipalities likewise are involved in this. Mr. Faust has raised an important and quite a basic question.

In other words, when we talk about reuse, are we talking about the reuse of the water out in the stream some place below an outlet, or are we talking or do we mean to interpret reuse as a reuse within the industry itself?

Both are involved in its proper interpretation. I personally believe that it is industry's responsibility to reuse the water within its own industry efficiently and not just to the point when it becomes uneconomical for it to reuse, and then dump whatever residue that remains into the outlet stream. The responsibility of reuse also extends to the reuse of water by downstream users.

I know of an industry at the present time that is taking a very excellent water and in its use increases the hardness to some 800 or 900 parts per million. It is uneconomical for that industry to remove that hardness and high saline content for their own reuse. It is cheaper for them to pump their water out of the ground and to discharge this high sulfate waste water into the outlet stream. I think that is probably an example of what Mr. Faust has in mind, and I very definitely agree and I think that is probably what his question is pointed toward—that it is an obligation in this particular industry that I mentioned to you to remove those hardness constituents so that they will not be detrimental as they are now to a water use downstream.

In other words, an industry has an obligation to the general public and the downstream users, if necessary, to go beyond their own water reuse, and that is a form of reuse beyond which it might be profitable to them to do so.

Also, they definitely have a responsibility for a more efficient water reuse within their own industry.

So reuse does imply an efficient reuse of industry as well as applying to an efficient reuse in the outlet stream itself.

**Mr. LAWRENCE.** The next question for Mr. Klassen is from Mr. John J. Meehan, of the Chamber of Commerce of the United States: ***"By your statements concerning water quality management, which would involve among other things planning, organization, establishing and maintaining controls, and so forth, are you suggesting eventually an overall czar on a national level?"***

**Mr. KLASSEN.** Of course, I could use the usual technique of a discussant by answering the question with a question. I am not too sure what he means by a czar. If he means—I think probably he does—a Federal agency or one person, we will say, in Federal Government who is going to dictate water policies all over the country on water reuse, then, no, I do not advocate that. I believe that, as I think I stated, within our present framework of government we can accomplish this water quality management program.

I am a States-righter. However, on the other hand, much of the criticism of Federal control of water pollution and water use comes from the States that have been themselves lax in facing up to the issue and doing something about it. I know from our own experiences in our own State, that a State can take care of its own water pollution problems, and if it becomes involved in interstate problems, that the interstate compact is the next avenue open. I do think that in the background there should be some ultimate Federal authority that can step in if all of the other machinery at local levels does not or cannot function or operate.

I do not have too much sympathy for the States that are crying "Federal control," and "czar," particularly when they themselves are not doing the job that they can and should do because of some reasons of local personalities and pressures.

**Mr. LAWRENCE.** This question to Mr. Klassen is from Mr. Harold F. Elkin, National Technical Task Committee on Industrial Wastes: ***"By providing modern principles of water quality management and extending and improving techniques of reuse and conservation, can we not promote an increased level of industrial and community productivity per unit volume of water in given areas?"***

**Mr. KLASSEN.** Well, it is apparently obvious that the answer to that question is "yes." However, I believe that not many of the industries themselves realize—and a lot of them still do not—the importance of production costs that are reflected in their own water problem. As some of you know, it was my privilege a couple of years ago to be a consultant to the Japanese Government, and I mention this because it is definitely impinging on this particular question.

The Japanese economy had reached the point where they had to force their land to produce food. We took away Korea, Formosa, and Okinawa. The old methods of using night soil and fertilizer with human wastes had to be discarded for the most part and replaced by chemical nutrients. Therefore, the night soil became a drug on the market and was and is being dumped into the Japanese streams. Finally, Japanese industry itself realized that one industry was causing another industry to have an increased production cost because of the particular water problem. That is when the Japanese industry got interested, and this law or new national stream pollution law was passed. Many Japanese industrialists indicated that they were beginning to realize the increasing production cost that their water treatment problems were involving, and that, of course, determined their competition on the world market.

From an over-all industry viewpoint, much of American industry has not yet realized what part of the "cost" of water is reflected in the production cost of their own particular product. I believe that as we see one part of the country and another part of the country facing up to these problems, that the answer definitely to this question is "yes."

I know from our own experience in the Ohio River Valley that industry cannot play one State against another so far as their treatment problems, and from one part of the country to another part of the country, wherever the water locations are. I feel that, coming back to the previous question, it could very well be there will have to be some overall national standards as the basis on which all industry would have to operate, at least as a goal.

**Mr. LAWRENCE.** This question to Mr. Klassen is from our chairman, Dr. Ackerman: ***"From the point of view of a State government, how should radioactive wastes be handled in the future if they reach significant volume?"***

**Mr. KLASSEN.** Well, I do feel a little competent from our own experiences to answer this question, while this is not a "Chamber of Commerce" type of statement. Unless Russia has a larger one, Illinois has the largest nuclear powerplant in the world. We now have it in operation.

I think the chairman raised this question, so far as the State and Federal Government are concerned, whether the Federal Government is preempting any of the State's authority in this field of radioactive waste control. I want to dispose of that question by saying that that is a legal question and as an engineer I do not intend to fight the legal battles of the lawyer and answer that particular question, because even if we did settle the legal question of whether the Federal Government or the State government has control over radioactive wastes, we in the State would still have the problem. Although some of the lawyers have advocated that the United States Supreme Court settle this question, I hope that it never does, because if it does, we will both lose, both the State and the Federal Government. The Federal Government and the Atomic Energy Commission, to be specific, need the help of the State agencies, and we in the States certainly need the help of the Federal agencies in this particular problem.

I might tell you exactly what is happening in our State with the power station that is owned by Commonwealth Edison and their associates.

The decayed radioactive wastes go into the Illinois River, from which Peoria takes its water supply downstream.

Two years ago the background count of our streams in Illinois, as in many places in the country, went above the rough base line of 100 micromicrocuries per liter because of fallout. The operator of the installation said, "What happens if the background count goes above this when we are in operation? Do we have to stop operation?"

It is a logical question because you just cannot "shut down a nuclear powerplant today and start it tomorrow."

We have worked out what we both think is a practical arrangement. I mention this because this is strictly a State operation. We have been securing background counts in the stream the 2 years prior to operation. We use the average of the past 12 months for the basis to figure the next month's discharge by the station and the first of every month the Illinois Sanitary Water Works files with Commonwealth Edison a statement of the level of the wastes that it can put in that stream during the coming month. Now, I detail that because it is a specific problem. The question of jurisdiction has never been raised. We feel that we as a State agency have a direct responsibility to the people of the State of Illinois. The Commonwealth Edison has certainly recognized that we also can be a factor, a public relations factor, in knowing what is going on. Our relations have been the finest right from the beginning of planning, construction, and operation, and I definitely know from our own experience that a State agency can face up to this problem of radioactive wastes from a practical standpoint. To do otherwise would be an abdication of some of their responsibilities. The sanitary engineer has taken this in his stride. I might say that we did not have to amend our water pollution control act in Illinois. We take radioactive wastes merely as another waste in our long list of wastes, one of which is a little more complex and one that has been magnified by scope and intelligence. Nevertheless, it is an industrial waste. It is one that the States can control. This is not a hypothetical statement, because as well as some other States we are doing it with the cooperation of the industry.

We have four reactors in the State now. To specifically answer this question in this field of radioactivity, the States have the prime obligation to the people to protect the streams even though the 1954 Atomic Energy Act might be interpreted in a little different manner. We are getting the job done, and a State water pollution agency needs the Federal Government in this for their competence, and the Federal agency involved in this definitely needs the State.

I think that probably summarizes my reaction on that question.

**Mr. LAWRENCE.** This question for Mr. Banks is from Mr. Alden J. Erskine, President of the Izaak Walton League of America: ***"Under what circumstances, if any, can you justify the use of a public stream for the disposal of untreated waste?"***

**Mr. BANKS.** Well, again I am going to have to say that I do not recall that I said anything about untreated wastes in my formal presentation. A waste is a waste, whether it is treated or untreated, and it must be disposed of. What I had reference to in my paper was the final disposal of the waste after whatever degree of treatment proves to be economical in the total situation concerned.

I will agree that I can conceive of very few circumstances, if any, which under the present state of our civilization and our culture, would justify the disposal of untreated wastes into surface waters. There may be such cases, but I do not know of them. The fact still remains that some fraction of the waste even if treated, must be finally disposed of to these waters, and it must be carried off by the water. In some cases that necessity may be sufficiently great to justify degrading the quality of the water in some reaches of the stream to the point where it will adversely affect aquatic life and fish and wildlife resources. But I repeat, in answer to the specific question, that I conceive of very few if any circumstances which would justify the discharge of untreated waste.

**Mr. LAWRENCE.** This question for Mr. Banks is from Mr. John J. Meehan, of the Chamber of Commerce of the United States. It is in two parts: ***"Part 1: In your opinion, who should establish water priorities? Part 2: I agree with your statement that comprehensive long-range water quality planning is essential, but is it possible that on the national level desire for planning might lead to a national water boss?"***

**Mr. BANKS.** I am speaking now of intrastate waters—at the present time there are only the State agencies which have the statutory authority and body of law to establish water priorities on intrastate streams. Now, speaking with particular reference to the West, this generally revolves upon a joint effort between the State engineer or the water rights board or whatever State agency administers water rights in the particular State concerned, working in collaboration with the pollution control authorities. In the East, of course, in certain States where there is no body of statutory law governing water rights, water priorities are pretty largely established by custom and by growth of the economy and environment.

I believe firmly that the matter of establishment of water use priorities is and should remain a State function. I don't believe that at the present time, nor do I see it coming in the future, there is an adequate mechanism at the Federal level to do the job.

Now, with respect to the matter of a national water boss, in my opinion there is need at the Federal level for some mechanism, call it a water boss or water czar or board of review or body of water coordinators or what you will—there have been all sorts of mechanisms proposed by all those who have studied the question—to coordinate the activities of the various Federal agencies involved in water development—Health, Education, and Welfare, Bureau of Reclamation, Corps of Engineers, Agriculture, Federal Power Commission, and the others which have some responsibility in this field. There is need for an agency to coordinate their activities into a comprehensive optimum development program. There is now too much competition and conflict between the Federal agencies. I believe it can only be cleared up by establishing some coordinating mechanism, probably in the Executive Office of the President.

**Mr. LAWRENCE.** This question for Mr. Banks is from Mr. Shaeffer: ***"Would you expand your idea concerning the use of zoning to mitigate pollution problems?"***

**Mr. BANKS.** Well, I can illustrate that, I think, by recounting a little of our own experience in California. Of course, we are fortunate. We have a thousand miles of coastline on the Pacific Ocean which has a fairly high assimilation capacity, properly used. Our interior streams, of course, are necessary for other purposes to a very large extent, and very shortly we are going to run out of waste-disposal capacity in these interior streams. From then on industrial development will have to be very carefully planned and carefully located with respect to the availability of waste-disposal capacity in the various water resources concerned, both fresh, surface water, and our saline off-shore waters.

I think there is need for study, and I hope it will go forward in our State in the not too distant future, of where industry can and should locate from the standpoint of waste disposal with a minimum of cost both to themselves and to the other water users of the State, in order to achieve proper waste disposal without adverse effect upon the other beneficial uses of water.

In the interior valleys, we can accommodate much more industrial development without either excessive degradation of our streams or provision of very extensive waste disposal systems to collect the wastes, and finally dispose of them to a point in the saline waters where they will do no harm. It is conceivable that economics may dictate that industry locate where waste disposal is relatively simple and cheap.

**Mr. LAWRENCE.** This question to Mr. Banks is from Mr. Roland C. Clement, of the National Audubon Society. ***"Is not the assignment of pollution quotas, instead of preventing pollution from the beginning, a form of water expropriation which will make multiple purpose allocation impossible?"***

**Mr. BANKS.** I think that question rests upon the concept that waste disposal is a nuisance. I do not happen to be one who regards waste disposal as necessarily a nuisance under all circumstances. I think it is a necessary facet of our culture, our economic environment, both urban and industrial, and agriculture. I do not see how, if you define pollution in the broad sense of quality deterioration of any kind—how you can absolutely prevent pollution. You can minimize it, but you cannot fully prevent it. There will be some quality deterioration, irrespective of all the treatment possible. The question is not the absolute prevention of deterioration but how much you can stand in the total economic and social picture.

Now, I believe that this question refers largely to social values, and I would not for one moment have you believe that I minimize in any way the social values of the use of our water resources. They are extremely important. But still and all, the objective must be economic balance in the total picture.

**Mr. LAWRENCE.** This question for Mr. Banks is from Mr. Harold F. Elkin, National Technical Task Committee on Industrial Wastes: ***"Mr. Banks referred to zoning for urban and industrial development. Since the normal pressures of water supply and demand influence industrial site selection, and thereby affect the growth of our urban areas, why not encourage community expansion in locations with adequate water availability and relieve some of the anticipated pressure on our water deficient areas?"***

**Mr. BANKS.** I can answer that one very simply. I think it is a fine idea. All we have to do is find the technique to do it. By what means people can be prevented from coming to some of these areas even in advance of industrial development, is a problem which we have not resolved yet. My own opinion is that in the broad field of planning, we should start at a more basic level than we do. Generally, in planning we start with the projection that there will be so many people in a particular location at the same particular point of time in the future and so we develop our design and provide the utilities, the water supply and the highways, and so forth, to meet that population. Possibly we ought to start a little farther back and form some opinion whether that population level is desirable for this particular location, considering all aspects, not only water supply, but waste disposal, air space, air drainage, soil, climate, availability of industrial locations, and all that sort of thing.

So again I would say I think the idea is very fine. All we have to do yet is to find a way of implementing it.

**Mr. LAWRENCE.** This question is directed to the panel. I shall ask for volunteers. It is from Mr. Royal H. Carlock of the Izaak Walton League: ***"Will the system of purifying brackish and saline waters remove detergents, insecticides, pesticides, viruses, and other unhealthful chemicals? If so, why not purify the effluent from our sanitary treatment plants?"***

I believe that Mr. Klassen touched on this in his paper.

**Mr. KLASSEN.** First of all, I do not know whether the process of desalting water would remove all of these things. I am under the impression that certainly multiple evaporation probably would take out most of them. So as to the first part of the question, I do not know the answer to that. The second part, if so, let's assume that it will. Why not use this to remove all of our sanitary wastes?

I think the answer comes back to the discussion that Mr. Banks just gave to the last question. It is a question of economics. I have said (and some of my Izaak Walton League and sportsmen friends have disagreed) that we cannot hope to have an 1860 water quality condition in a 1960 industrial economy and expansion. I do not mean this as a defeatist statement, but I say this because I believe it.

We pay a price for our particular form of government and industrial energy, and for me it is worth it. One of the prices that we have to pay for some of the improvements, some of the standard of living, some of our industrial expansion, is the price of not having the 1860 water quality, water of pristine purity, if you want to take one of the phrases of some of our sportsmen friends.

Coming back to the question whether it would be possible to remove all of these things by evaporation of our domestic wastes, it becomes basically a question of whether first of all it is necessary and whether it is economically feasible. Maybe we, as I said in the paper, cannot afford not to do it, and it resolves itself into a question of what is pollution. I think that was answered in a previous question. We have a definite definition of pollution in our Illinois law which our courts have held is a bill of particulars when we say to an industry or a municipality that they are causing pollution in accordance with this definition.

I am not going to read this definition, but as long as an industry or a municipality is not affecting the waters according to that definition, they are not causing stream pollution. That again means that there obviously are wastes that can be discharged into streams without causing pollution.

**Mr. LAWRENCE.** I think the questioner in this case had in mind the fact that assuming effluent is less complex than some of the saline waters we are working on.

Governor Aandahl, I wonder if you could comment on this question.

**Mr. AANDAHL.** There probably is not too much that I can add to what has already been said. I would like to advise, though, that in the saline water conversion plants we have also a problem of disposing of the waste. The conversion plants will take about half of the volume of water and make pure water out of it and return the other half with double the load of brackish materials. So we have the problem of disposing of wastes in the saline water conversion plants. I think those plants will remove some of the elements of pollution that are found in industrial wastes—just which I am not sure—but that would be a matter for engineering review. But we still have not removed the problem of pollution disposal, because in the conversion plants we also have a waste being disposed.

**Mr. LAWRENCE.** Thank you, Governor. This is a good question. We have a comment now from Mr. Banks.

**Mr. BANKS.** I will be more bold and volunteer a further answer.

This question seems to refer to the wastes produced by municipalities and industries, and I would infer that the individual concerned is thinking in terms of all industrial plants. I think we fall into an error in our thinking if, in considering the matter of pollution and waste disposal, we limit our thinking solely to municipal sewage and to industrial plant waste.

In the West, and I suspect this may become increasingly true in the East as time goes on, a very significant pollutional load on our streams is from irrigation return flows. Irrigation return not infrequently contains significant amounts of pesticides, agricultural chemicals, insecticides, and that sort of thing. Obviously, when you have some 7 million acres of land under irrigation, probably with a return flow in the order of not less than a half-acre foot per acre per year (in some cases it is far higher), it is impossible to treat that type of waste in that magnitude before it returns to the stream if only because of its sheer magnitude, to say nothing about the impossibility of attempting to collect it, because some of it returns to the ground water and then moves laterally and feeds into the streams by effluent seepage. So again this comes back to the point that I tried to make in my paper. You have to expect and anticipate there must be some deterioration in quality, and there is not much you can do about it. We have to face that fact, as has been previously stated, because there are situations where it is an obvious impossibility to prevent it.

**Mr. LAWRENCE.** This question is also for Mr. Banks or Mr. Klassen: ***"Since pristine purity is not obtainable and some pollutants must be received by our waters, who is to determine the purity standards for the permitted pollutants?"***

**Mr. KLASSEN.** I will volunteer this time, Mr. Banks. The reason I volunteer is because an answer is easy.

Under our form of government, not necessarily the person by name, but we will say the agency by name which is to determine pollution, obviously is the one that is designated by the legislative branch of government. In our own State, my own personal views do not necessarily apply to the Illinois program. We have a very definite responsibility charged to us by the Legislature, and any time that I do not agree with that, of course, I have the opportunity to quit and go some other place.

So I would say that when you ask the question who is to determine this, the people are to determine it through their own representatives. If it is in a State, it is the State legislature; nationally, through the Congress. I think that that is the only obvious answer to this.

We have in our Illinois law a statement of policy, a definition of pollution, and a procedure that we must follow. We have been designated as the agency to determine whether a stream is polluted according to the definition of pollution, and I think probably that is the answer. Any time an organization or the people in an area and a State or the country are not satisfied with the way the program is going, they have the obvious alternative to appeal to the legislative branch of government, so that the executive branch can follow the dictates of the legislative branch. I think it is just that simple.

**Mr. LAWRENCE.** This question is from Mr. Balmer of Du Pont and is directed to the panel: ***"We talk about meeting the need for more water, with very little mention of what can be done to reduce that need by all users. Now, the greater cost, if cost is the charge, can do a great deal to reduce us below the commonly predicted amounts, and very little has been said about that."***

**Mr. BANKS.** In connection with our statewide planning in my State, we have conducted some studies of the influence of changes of cost of water on the use of water in urban communities. There is some degree of correlation between cost of water and the amount of water used, but within the ranges studied, it does not seem to be too significant. One of the things we found is that with an increase in water rates, water consumption goes down for a short while. But then it builds up quite rapidly and comes back to the same trend that it had before the increase in rates went into effect.

As far as municipal supplies are concerned, I think we must recognize that a very high proportion of the cost of municipal supplies is in the distribution of the water, not in the source cost. You might double the source cost or even triple it without making a corresponding percentage increase in the cost of the water to the consumer. I suspect that as far as municipal use of water is concerned, you would have to raise the price to the consumer considerably before you would have a pronounced effect upon the rate of consumption.

Agriculture displays a much greater elasticity of demand; that is, the use of water by agriculture is much more sensitive to the cost of water to the irrigator than is the case in municipal supply. This, of course, has been advocated by some economists as a means of increasing the efficiency of water use.

I would venture the opinion that control of water use through the pricing mechanism would be extremely difficult from a political standpoint in a given community or in a given irrigation district. I have asked some water purveyors what they thought of the idea, and they shuddered at the thought of raising the cost of water to the consumer as a means of increasing its efficiency of use. I suspect there would be all sorts of protests, protest marches on city hall, and as far as farmers are concerned in some irrigated areas if you raised the price of their water by 25 cents an acre-foot, you would have open rebellion on your hands immediately. So, from the standpoint of theoretical economics, it is a good idea, but I do not think it stands much chance of being put into effect.

**Mr. KLASSEN.** I merely want to mention this, because I wasn't going to volunteer until Mr. Banks mentioned this.

Some of you may be familiar with the whole pattern of the planned water economy in Israel. It is probably one of the tightest and the finest controlled water controls any place in the world, and they recently did this very thing that Mr. Banks mentioned. That is the reason for my mentioning this. They have determined the needs of the average family, and beyond that, instead of water getting cheaper as you use more, that country has put into effect what they call the "reverse sliding scale." Above the average amount which the average family needs there is a tremendous and a sharp increase in rates beyond that amount, rather than a decrease.

**Mr. LAWRENCE.** Mr. Alden Erskine has requested to make a statement. Mr. Erskine is president of the Izaak Walton League.

**Mr. ERSKINE.** If we are to maintain the dignity of our society and achieve desirable objectives, we must go home from this very important meeting with sincere obligations and honest intensions to put into action the findings of this meeting. We are, I am sure, aware of the common law of averages, but I am sure we will all agree that just average has not been good enough, in pure foods, in our schools, our paved highways, and the many other things we have learned to expect as a part of our American way of life. By the same token, if we are going to meet the water needs of all segments of our society, we must demand and cannot accept less than clean water, and I must say "clean" twice.

## PANEL II, Afternoon Session

**Dr. E. A. Ackerman, *Presiding***

We start this afternoon's session and the final session of Panel 2, that is, pollution control as a means of increasing water supplies, with a somewhat longer session than we had this morning, but I think you will agree, just as interesting a one as this morning. We have four speakers and discussants for each of the presentations which those speakers will make.

# Water Quality Intelligence

THOMAS J. POWERS
*Consulting Director*
***Dow Industrial Division, Dow Chemical Co., Cleveland, Ohio***

The title of this paper may have a different meaning to every person who sees it. To me it means knowing our waters. I would propose to prove that we must know our waters. I would propose to prove that we can only know our waters through organized, systematic data gathering.

This data gathering is not easy to sell. I have found the ordinary citizen to be quite unsympathetic toward data gathering.

Many years ago we made a water quality survey of Saginaw Bay. During the winter, with the Bay covered by ice; we would sample from a special car with an ice drill. One day 20 miles out from the Saginaw River and 5 miles from shore we stopped for a sample. There was a lonely fishing shanty not 50 feet away. As we started the ice drill down, the door of the shanty flew open. A fisherman popped out and wanted to know what we were doing. Our answer, "tracing pollution." After a moment's thought he remarked, "Hell you won't find any out here. Why don't you look in the Saginaw River?" You see, pollution meant an evident thing to him. He had no sympathy with our efforts to locate a point of least pollution for a water intake.

When I first started working for industry, my boss made it very plain that my job was to know more about our pollution problem than anyone else. For instance, if something happened in the river, it was my job to know about and be able to define the problem before anyone else. Now, something is always happening in a river. It was my job to know the what, where, who, and why.

To conform with this mandate, it was necessary to expand an existing river and sewer surveillance program. It was also necessary to train people to recognize pollution by test, by sight, and by odor.

At one time we had five continuous conductivity recorders on water intakes above and below our operations. We had a daily sampling of the rivers above our plant and below it. Sewer sampling was hourly around the clock. What happened to the data we collected? They were used to find and eliminate haphazard pollution, they pointed up the need for further controls and they measured progress.

Our communications with upstream and downstream water users were excellent. Alerts were sounded for unusual conditions whenever and wherever they were found, above us or below us. On many occasions it was necessary to call upstream industries and tell them they had a loss. We had to communicate to protect our own position.

This type of surveillance has been in practice for over 30 years and I believe it to be a good example of what we mean by "water quality intelligence," the need for it, and the uses to which it can be put by an industry.

There are many water quality intelligence programs in the United States. Perhaps the oldest is that of the U.S. Geological Survey. As of now, this agency maintains 290 daily sampling stations with an additional 320 stations operated on a monthly or weekly sampling basis. The purpose of this program is to provide industry and the public with information about the chemical quality of surface waters. The survey also provides information on minor trace elements as well as radioactive elements. While the compiled data of this program may be useful for pollution control, this was not the primary aim.

The Public Health Service saw a need for long term data on the changes in water quality affected by pollution. In 1957 the National Water Quality Network was established. There are 74 sampling locations on our major waterways and international waters. The data collected will show the trends in quality as measured by bacteria, by organic content, by oxygen level, by plankton, by radioactivity determinations, and others.

It is anticipated that this program will be expanded to 300 stations. The participating agencies are State health departments, municipal water departments, other Federal agencies and industries.

These agents collect samples and do normal analyses while the Public Health Service performs the more sophisticated analyses, compiles the data and publishes the compilation yearly. The Public Health Service, in conjunction with the U.S. Army Corps of Engineers, is active also in 56 projects in 17 States on comprehensive studies of pollution and water supply requirements.

The Ohio River Valley Water Sanitation Commission has operated an interstate monitoring system for 8 years in cooperation with its signatory States, the U.S. Geological Survey, the U.S. Corps of Engineers, municipal and industrial waterplant managers. Stressing the hazard and alert possibilities, this system is operated to avoid damage through gross pollution as well as to build water quality information for future decisions. All information is communicated to the ORSANCO office, which acts as the collecting and communicting agent. ORSANCO has in operation some 43 monitoring stations. This systematic data collection and communicating program did not happen over night. It has taken 9 years to develop under the persevering and visionary leadership of Edward J. Cleary, ORSANCO's Executive Director.

Every State that has an active water pollution control program has a water quality intelligence program of some sort. I do not believe we are sufficiently organized in spite of all the necessary programs I have mentioned.

In support of this belief there are three questions I must try to answer:

I. Why do we need to organize for better water quality intelligence?

II. Who is to be organized?

III. How do we organize and how do we accomplish the aims?

In answer to the first question "why," it seems apparent to me that this ever increasing competition for water is going to demand an ever increasing pressure for water quality control. This means water pollution control.

Problems arising from the increased use of water might be likened to problems growing out of the increased use of our hightways. More restrictions are required, more alertness and courtesy are demanded from the users, more uniform laws, signals and signs are installed, and more studies are made to minimize danger to life and property.

If we are to control the pollution of our watercourses, it would seem that sufficient data must be gathered to—

1. Avoid as much damage as possible from instances of gross pollution.
2. Define the effects of pollution on water uses.
3. Measure the effectiveness of existing controls.
4. Establish the methods to be used for the most economical control.
5. Maintain control and provide proof of need for further control.

We are still talking about "why." Under point (1) we must face up to the fact that inadvertent gross pollution occurs and will continue to occur. If we are to protect water users, we much organize to communicate instances of such pollution. Even rain can cause gross pollution. About 6 years ago a hurricane rain was reported to kill an oyster crop worth several hundred thousands of dollars. This was not from too much fresh water. The fresh water wave passed too quickly to do damage. Organic matter washed from the land settled in the estuary and slowly depleted the oxygen. Witness also, the bypass from combined sewer systems even on small rains. A brief hard rain in Pittsburgh may materially affect water quality in Cincinnati 2 weeks later.

Other cases of inadvertent gross pollution could be similar to one we experienced. One night a transport company released a whole tank truck of phenol to the sewers of a large Midwestern city—50,000 pounds in a few hours. We called the manager of the sewage system the next morning. He in turn alerted the water works and sewage treatment plant. As I said before—these things happen.

I have heard of a $250,000 loss incurred by an industry because of a lack of communications. I have also heard of many cases of gross pollution where every water user was properly notified. Potential damage to life or property was minimized.

Under point (2), the definition of pollution effects, I do not see how we can convince a judge or a jury, a city council or industrial management that controls are necessary unless we can show damaged usefulness. Very few pollutors recognize a pollution problem until they receive a complaint. How many people pay a bill before it is rendered?

So far we have initiated controls ahead of radioactive pollution. Let us insist that research on pollution effects be done before other new materials are permitted to reach the water environment.

Having attained corrective measures the effectiveness of these can only be measured in receiving environment. That's point (3).

Treatment plant efficiency data are necessary to establish design parameters. Our State health departments demand performance reports. I would submit that data on the receiving water is the data which can truly measure performance and the adequacy of that performance. I am impatient with curves depicting industrial growth rates. Too often these are used to imply equal pollution rates. I am also impatient with graphs showing money spent on waste control. Too often these imply an equal reduction of pollution. The *only* data for these answers is water quantity data.

Point (4). Water quality intelligence can definitely establish methods to be used for the most economical control. The record of the chloride changes in the Ohio River pointed out the feasibility of storage and controlled discharge for brine wastes. The knowledge that certain organic materials rapidly disappear and others persist point the way towards effective control.

Under point (5), how can we maintain control and point up further needs unless we know existing and past conditions?

Back to our highways. I believe you may agree that there is only one good control for speeding. It is not the law. It is not the signs. It is the well equipped and conscientious traffic officer. Constant surveillance is the only way we can insure the gains and point up deficiencies.

Now, let us explore question II, "who" is to be organized. Naturally enough, the water control agencies must have facts in order to administer the pollution control laws. Not only must the control agencies be a part of organized water quality intelligence, they owe it to the public to initiate it. This may be largely an educational job. None of our water control agencies has been given enough budgetary support to actually carry out a day to day program without a tremendous amount of cooperative efforts from others. Very few of the agencies are presently staffed to even serve as a clearinghouse for information. It would seem that these agencies, Federal, State, and interstate, have a selling job to do if we are to arrive at any semblance of an organized effort.

My definition of a water user is any organization which uses the watercourse for water supply, effluent dilution or any individual using it for recreation.

Every water user has a responsibility under common and statute law. How can the water user assure himself that his use is within the law unless he knows the effects of that use? Further we would ask, "How can a water user intelligently use a water unless he knows its quality?"

The water user is the one most concerned about immediate quality changes. He is the one in the best position to observe water quality

Let's take a look at question III, "How do we organize, and how do we accomplish the aims." Some years ago we had an eager intake screen operator who had a habit of calling the conservation officer every time he saw a dead fish in the river. As soon as the word reached the officer, he would call me. We would meet at the plant gate to start an investigation although the fish might be 12 hours gone.

After several of these instances we encouraged the screen operator's boss to ask him to at least give us equal notification so that we could start an investigation before the fish was too ripe.

I make this point to emphasize that the justification for stream surveillance and monitoring depends on the proper organization of communications. This, I believe, is the most important element of a good program.

If we know who needs information about water quality, I would propose that the system of communications be worked out first.

How would we achieve this first element? If it cannot be achieved there is evidently no need for a program.

Let us start with a watershed containing a number of diverse water users. The control agency must take the initiative to educate these users to the need for organization and to call a meeting for this purpose. The size of the watershed is *not* important. The number and types of users *are*. The user with the largest stake in water quality would be the most natural to select as the intelligence collecting and communicating agent. This requires a 24-hour telephone number, a mailing address and a person with a mind capable of assessing the importance of information received about water quality. This agent then transmits all information to other water users and the control agencies. Each user should gladly pay his proportionate share for such service. If not, the program needs more education, more selling.

We must assume that the most important element, communications, has been established. There is a need for the program. Now, again, "how,"—how do we establish what kind of information is needed and how do we get it.

Information about the discharge of each watercourse under surveillance is absolutely necessary. The growing competition for water demands that we assess the available supply during all periods of the year and over many years. We must also know the time of flow between water users under all flow conditions. On regulated streams, we should not only know the time of flow but the time of gradient change. Without these data, it is almost impossible to evaluate water quality changes. The U.S. Geological Survey Surface Water Branch can aid in establishing a stream gaging program if one is not already in existence. There are 6,825 active stream gaging stations.

What other measurements could be considered essential?

I believe water temperature is important enough to be recorded continuously.

Water conductivity can be recorded continuously and is an indication of the variations in dissolved salts.

Chlorine demand or oxidation—reduction potential can be recorded continuously and relates to organic matter present.

In certain basins pH or hydrogen-ion concentration may be important.

Dissolved oxygen can be recorded, so can turbidity.

Soon we will have oxygen demand recorders which will accurately define the organic changes.

It would seem that ORSANCO is proving, through its robot monitor, that we could instrument a monitoring station to give us a continuous record of quality and quantity. Such a complete station could transmit information to any central location. Such a station might also cost many thousands of dollars to build and much more to operate. Considering what we spend on the conduct of sporadic streams investigations, the cost of such a station would not be considered prohibitive.

I do not believe that we must start with such a sophisticated program. The most important phase, initially, is the education of water users to responsible action. No amount of instrumentation can replace a conscientious effort on the part of each water user to be responsible for communicating.

As a starter I would suggest:

1. Form a water-user organization in each watershed of more than two users.
2. Designate one water user as the intelligence collecting and communicating agent.
3. Establish the operating procedures, data required and frequency of observation.
4. Commence operations and adjust procedures as found necessary to accomplish the aims.

The proposal then is to expand our water intelligence programs on all fronts, Federal, interstate, State and especially on the local watershed level. The water user must be taught the importance of communicating. His intelligence must be received by someone who can act. The ordinary citizen in a boat or on the beach is a water user too. His support of surveillance programs is needed. In essence: I believe that we cannot afford to wait for someone else to tell us what our waters contain. We, the water users, must know and must communicate this knowledge—this water quality intelligence.

**Dr. ACKERMAN.** Mr. Powers, I like the point you made, and which I certainly think deserves requoting here. Industries are water users in other ways than waste disposal, and they have a stake no less than the rest of the public in the cleanliness, or the quality, of water, and that there is a balance to be achieved even among industries in the use of a stream. Industries have a large stake, as Mr. Powers noted so effectively, in water quality intelligence; and so do we all.

## DISCUSSION

### MORRISON B. CUNNINGHAM

***Superintendent and Engineer, City Water Department, Oklahoma City, Okla.***

I like the definition given by Mr. Powers for the meaning of the term water quality intelligence: "it means knowing our waters." And I agree that we can know them "only through organized, systematic data gathering." But I like best of all his statement which contains specific suggestions as to what we must do to "know our waters" and I want to quote this sentence from his statement:

> To conform with this mandate of knowing our waters, it is necessary to expand an existing river and sewer surveillance program; train people to recognize pollution by taste, by sight, and by odor; and to conduct daily sampling of the rivers above our plant and below it.

In making that statement, Mr. Powers refers to a plant in an industry he so ably represents. But in the broad purposes of these deliberations there are principles deducible from his remarks which are of general and vital application.

He speaks of "river and sewer surveillance" programs. For what purpose? Obviously the purpose, among others, is to determine the conditions affecting river flow; changes of conditions affecting runoff in the watershed drained by the river; conditions affecting or contributing to the contamination of the water.

Mr. Powers states that his plant analyzes samples taken from the river daily, both above and below the plant. Why below it? Obviously there is need to make sure that water returned to the river after use by his plant has acceptable quality for reuse.

Thus the statement used by Mr. Powers encompasses a vast field of subject matter relating to quality of water: condition of existing water, its degree of utility, the prospects of future contamination of supply, the prospects of continuing purity, or utility of supply, coordination of effort, and finally a complete recognition of the principle that the right to use water confers no right to contaminate it, or to pollute it.

Mentally, substitute for this industrial plant all our cities and their growing populations of individuals and industries; the constantly expanding needs to provide for disposal of increased concentrations of waste; the continuous flow of discoveries for new uses of water in vast quantities—and it seems to me that the approach made on the basis described by Mr. Powers is one of the best possible arguments supporting Public Law 660 passed by the 84th Congress.

No law is self-executing. It must be administered by somebody. The Public Health Service has accepted the challenge, and the Surgeon General is ready with his public health personnel to preserve and protect the water we have, working in close cooperation with industry, state and local government forces.

Outside of rationing or some other arbitrary limitations of use, preservation and protection mean the maintenance of water in safe and usable condition as long as it remains water, and thus multiply the number of times it can be reused.

In my opinion, every phase of the work on pollution control implies water quality intelligence. Making investigations on river basins to obtain data on sources of pollution is of extreme importance. The Arkansas-Red River Basins investigation is an example. One of the principal sources of pollution is the high chloride content of the water. The investigation of these streams requires highly scientific skill to approach a solution to this manifold problem, to determine the source of the pollution, both natural and man made. The survey is making very good progress. Pollution points are being located, and it appears that a good portion of the natural pollution can be minimized, and the man-made pollution, such as the brine, can be greatly reduced by disposal wells. There is a good prospect that effective pollution control, will improve the quality of the water to the extent that it can be used for municipal supplies.

Field investigations and the gathering of such data are excellent examples of the meaning of water quality intelligence discussed by Mr. Powers.

The time has come when we must take a more complete look upon water in all its phases of quality, from water supply to sewage. Usable water is our natural resource, and it must be conserved for use. The right to use water does not give us the right to destroy its reuse.

Another phase of the work being done is the conduct of effective public hearings, especially in the areas where the pollution originates. A good example is the public hearing on oil field pollution in Louisiana. Before the public hearing, the waters of the stream had been ruined by the introduction of salt water. Shortly after the hearing, the pollution was minimized to the extent that the waters of the stream have now returned to near normal conditions—fish and wildlife are beginning to return—and the water made usable. Another example of water quality intelligence being practiced, of course, is illustrated by Mr. Powers' account of his meeting with the fishermen in Saginaw Bay.

We commend the Water Pollution Control Advisory Board for the hearings they have conducted in several cities in the United States. When they held one of their meetings in Oklahoma City, they were greeted by industry who was proud to show the progress which had been made in eliminating most of the brine previously introduced into the streams. The salt water is now being introduced into disposal wells. This illustrates the willingness of industry to cooperate, especially when they see that a uniform policy is being followed.

The elimination of the pollution going into the streams in the Oklahoma City area had been a problem for 20 years or more, and was solved in less than a year's time. This was done by the wholehearted support of industry, and Federal, State, and city governments working together. This cooperation is becoming more and more evident in today's conservation of water resources, and related environmental health problems.

Time does not permit me to go into detailed discussion, but I should like to mention a few additional phases of what we could call water quality intelligence—for example, wet and dry cycles occur. There is every reason to predict that a dry cycle, such as we had in the 1950's, will recur in Southwestern United States in 1970. Past experience shows we can expect a year or so of drought during wet cycles. When the next drought comes, it will be those areas that were wise enough to insure enough available usable water that will continue to prosper.

Numerous reservoirs are being constructed in Oklahoma to assure adequate water supply. Weather modification to increase precipitation, saline water conversion, and evaporation control are other measures being taken. Continued research of this kind is of great importance. In some areas water for dilution should be included as conservation in reservoir storage.

The American Water Works Association is very much interested in all phases of water pollution control, especially research to improve water quality.

Municipal, industrial, agricultural, and recreational users of water must continue working together and take every possible action to make certain that our own houses are in order with reference to the problem of control, and prevent pollution. Senator Kerr, in his book *Land, Wood and Water,* says "we must protect and improve what water we have, and we must find more water. That is the price of survival." The American Water Works Association members serve 125 million people through 20,000 water systems. We join with you in the belief that we must continue and accelerate the practice of water quality control. We are heartily in favor of continued research to keep abreast of our complex problems.

During the drought, Horace Thompson, a newspaper reporter friend of mine, frequently used the expression which I think is appropriate when we talk about water—for we know that "Water Is Cheap, When Plentiful—Priceless When Scarce."

**Dr. ACKERMAN.** We return to a subject that we started on this morning, that is, comprehensive development of watershed or river basins. One of the things that has come out in this session, at least to me, is a new note in comprehensive development, namely, important State voices speaking up for it in no uncertain terms.

**Dr. WOODRUFF.** Before I proceed with my paper, I would like it to be noted on the record that we have present with us from our study commission five of the members, in addition to myself: Ralph Hammond, from Alabama, John Short, from the Department of Agriculture, Howard Chapman, from the Public Health Service, Walter Gresh, from Interior, and William Hiatt, from Commerce. Others would have been present but for unavoidable conflict.

Let me mention also that we do have on this staff which Dr. Ackerman referred to, Mr. George Tomlinson, Executive Director, who is present, and Mr. Richard Poston, of the Public Health Service, Planning Engineer.

So we are vitally interested in this entire subject for which the President directed that this Conference be held.

# River Basin and Multipurpose Planning

James W. Woodruff, Jr.
***Chairman, U.S. Study Commission***
***Southeast River Basins, Atlanta, Ga.***

River basin and multipurpose planning is one of the activities that can help meet the growing competition for water. The United States Study Commission—Southeast River Basins is a new approach to river basin planning. In the comments that follow, I would like to answer the questions of what the Study Commission is; how the Southeast Commission differs from other planning organizations and how the planning job is being accomplished in the Southeast. Finally I would like to commend the Study Commission approach to you who are interested in water resources, especially water pollution aspects.

The United States Study Commission for the Southeast River Basins was authorized by the Congress in late 1958 under Public Law 85–850, which specifies how the Commission is to be organized, what its purposes are, and how it is to function. The Commission has 11 members and is made up of a Chairman, and a member from and selected by each of the States of Alabama, Florida, Georgia, and South Carolina and a member from each of the principal land and water Federal agencies: Army, Commerce, Health, Education, and Welfare, Agriculture, Interior, and the Federal Power Commission. All of the Commissioners are appointed by the President of the United States. In order to serve as chairman it is necessary, according to the act, that I be a resident of the area.

The area to be studied covers about 88,000 square miles in the States of Alabama, Florida, Georgia, and South Calolina (plus a small area of about 200 square miles in North Carolina).

The act requires the Commission to prepare a comprehensive and coordinated plan specifically including eleven functions which are listed as:

1. Flood control and prevention;
2. Domestic and municipal water supplies;

3. The improvement and safeguarding of navigation;
4. The reclamation and irrigation of land, including drainage;
5. Possibilities of hydroelectric power and industrial development and utilization;
6. Soil conservation and utilization;
7. Forest conservation and utilization;
8. Preservation, protection, and enhancement of fish and wildlife resources;
9. The development of recreation;
10. Salinity and sediment control;
11. Pollution abatement and the protection of public health.

There is also a twelfth item which reads:

> And such other beneficial and useful purposes not herein enumerated.

Thus, the charter is very broad.

The Commission is directly responsible for all policy aspects, and the chairman of the Commission is charged with the administrative job of getting the work done. The authorizing Act details the responsibility to the chairman for: the appointment and supervision of personnel; the distribution of business among such personnel; and the use and expenditure of funds; all, of course within the general policies established by the Commission.

It is stated in the Act that it shall be the policy of the Congress to recognize the primary responsibilities of the States and local interests in developing water supplies for domestic, municipal, industrial, and other purposes and that the Federal Government should participate and cooperate with the States and local interests in developing such water supplies.

Throughout the Act, there is the reference to both land and water resources. There have been many authorizations to study specific water resources of an area and a number of them to study water and related land resources; but in our studies we are placing equal emphasis on the land and water functions. Also, we have considered each of the enumerated functions coequal. None of the purposes listed in the act is considered supplemental or subordinate to the others.

The Act gives certain guidelines to be followed in the formulation of the comprehensive and coordinated plan or plans. They require us to make use of available data from existing Government agencies; to encourage and, in fact, to stimulate an accelerated program of such agencies; to take into consideration existing projects; to provide certain economic evaluations and cost analyses and, quoting directly from the act:

> The Commission shall seek to secure maximum public benefits for the region and the Nation * * *

I gather that the intent of Congress in authorizing this study was for the Commission to take both a regional and national viewpoint in making the studies.

The United States Study Commission has some characteristics built into it by the authorizing legislation that make it unique and different from other planning groups. I mentioned earlier that both land and water resources are included, and all functions have a coequal status.

The U.S. Study Commission is clearly established in the law as a planning group with no future responsibilities for construction or operation. I believe this was deliberate and is one of the aspects that makes the Study Commission organization unique for planning resources development. The Commission and the staff are automatically dissolved three months after the report is submitted to the President.

Every effort will be made to have as much as possible of the actual work of the Commission done under cooperative agreements with Federal agencies, State organizations, and private entities. The Act authorizes us to work on this basis, and we are using, as much as possible, existing know-how from these sources.

To get the job done, the U.S. Study Commission staff contemplates four over-all steps. The *first* is that of taking basic inventory of the resources; *second*, analyzing and projecting the future economy of the area as a basis for establishing needs, as of certain future dates; *third*, preparation of single-purpose alternatives from each functional viewpoint; and *fourth*, formulating a single comprehensive plan. Although I enumerated these four as steps, I hasten to make clear that they are not distinct steps in the sense that we can say on a given day that we have completed step No. 2 and then start step No. 3. Actually, the steps will be proceeding concurrently.

As a part of the basic studies, we are making projections of major segments of the economy of our area for the year 1975 and the year 2000. These two years have been selected as the bench mark dates for the Southeastern Study.

Using projections of the basic economy, such as population, income and employment at those time levels and using several assumptions as to rates of development, we will estimate the various needs and requirements for resource development as related to the 11 or 12 functions specified earlier. Many of our needs will be shown by curves which may cover considerably more years than just those two bench mark dates. In each case, determining requirements are going to take a great amount of joint study to be sure that our assumptions and criteria are sound.

After we estimate the requirements, we will develop single-purpose solutions for meeting the requirements in each of the 11 or 12 enumerated functions. In many cases, the computed needs or requirements will not be determined by considering only the Southeast basins area. We have set up this intermediate step of seeking solutions for each of the several functions even though they may serve only as temporary answers which will fade out of the picture in terms of the final report, other than as passing references as to what we would like to have done had we not had to make adjustments in developing the best over-all plan to serve all purposes.

When we do get to the point of developing an optimum overall plan and coordinating some of these competitive single-purpose solutions which may be mutually contradictory, we may have some real problems. The merging of the individual plans will take careful treatment. As we finally develop the best plan, we will have to apply the acid test of analyzing each separable segment: first, to see whether it is justified; and second, whether there is any more economical way of providing a satisfactory solution.

After we work out an ultimate plan, we will program it by item. It may be that some of the items will be included in the ultimate plan even if they are found to be not economical and justified until industrial and other development reaches a certain point. Thus, we may have to keep in mind that any conclusion as to whether something is or is not economically justified has a relationship to the time at which it is to be developed.

In addition to the so-called functional approach, we are concurrently establishing an economic framework for use in planning. The more or less conventional methods of economic analysis and projection are being used. Also, we are checking portions of this economic framework by the use of econometric relations. This economic framework will provide the over-all target at which the functional studies are being aimed. We believe that this will result in a reasonable, comprehensive, multipurpose plan for our area.

The Commission coordinates its studies at the local level with all interested agencies engaged in land and water development work. This is done by means of public hearings, advisory groups, and committees.

The authorizing Act makes provision for a formal review of the finished report by the Governors of the concerned States and by Federal agencies at departmental level. Their formal review comments will be considered by the Commission and will accompany the final report of the Commission when it is transmitted to the President and to the Congress.

Throughout our study to date we have been diligent in carrying out that portion of the Act which charges the Commission to recognize the primary responsibility of States and local interests. We have interpreted this to mean that various subdivisions of government, as well as private enterprise and individual local groups, not only must be sought out for cooperation and, in fact, assured of our cooperation, but they also must be alerted to and reminded of their responsibilities to study, prepare and implement this or other well-conceived plans which will lead to maximum development of those vital resources for the general welfare of the people and the inevitable growth this Nation is destined to achieve.

I think it is rather apparent in the planning field that local interest groups are usually the motivating force. They may be interested in irrigation or navigation or hydroelectric power or recreation or in any one of the several special fields in which they are concerned. Special interests are not particularly interested in or concerned with what the other fellow wants or needs. In this competition for available funds, direct conflicts develop. Ideally, the objectives of planning should be to develop the maximum net public benefits. In the case of Federal programs this means developing maximum net benefits from a national viewpoint. However, since our comprehensive plan will undoubtedly include many non-Federal programs and projects, those projects to be attractive to their developers must be designed to create maximum net benefits from local or regional points of view.

To carry out the intent of the Study Commission act, it was necessary to establish certain policy and guidelines which are briefed as follows:

1. A comprehensive and coordinated plan for the development of land and water resources will be based on requirements of the economy projected for the year A.D. 2000. This plan will establish an initial action phase to include programs and projects which are found to be needed, feasible and desirable for accomplishment by the year 1975.

2. The final plan, including the initial action phase for 1975 and the long-range development phase for the year 2000, will be recommended for approval by the President and the Congress. Specifically, the initial action phase of the comprehensive plan will be recommended for such additional studies as required to support the request for needed authorization and appropriations by respective Federal, State, local government, or private interests.

3. Each of the functions enumerated in the authorizing Act, such as the previously mentioned pollution abatement and public health aspects, will be treated as a primary function and will be integrated into the final comprehensive plan. In the treatment of the function on industrial development, we do not propose to designate a specific

Throughout our study to date we have been diligent in carrying out that portion of the Act which charges the Commission to recognize the primary responsibility of States and local interests. We have interpreted this to mean that various subdivisions of government, as well as private enterprise and individual local groups, not only must be sought out for cooperation and, in fact, assured of our cooperation, but they also must be alerted to and reminded of their responsibilities to study, prepare and implement this or other well-conceived plans which will lead to maximum development of those vital resources for the general welfare of the people and the inevitable growth this Nation is destined to achieve.

I think it is rather apparent in the planning field that local interest groups are usually the motivating force. They may be interested in irrigation or navigation or hydroelectric power or recreation or in any one of the several special fields in which they are concerned. Special interests are not particularly interested in or concerned with what the other fellow wants or needs. In this competition for available funds, direct conflicts develop. Ideally, the objectives of planning should be to develop the maximum net public benefits. In the case of Federal programs this means developing maximum net benefits from a national viewpoint. However, since our comprehensive plan will undoubtedly include many non-Federal programs and projects, those projects to be attractive to their developers must be designed to create maximum net benefits from local or regional points of view.

To carry out the intent of the Study Commission act, it was necessary to establish certain policy and guidelines which are briefed as follows:

1. A comprehensive and coordinated plan for the development of land and water resources will be based on requirements of the economy projected for the year A.D. 2000. This plan will establish an initial action phase to include programs and projects which are found to be needed, feasible and desirable for accomplishment by the year 1975.

2. The final plan, including the initial action phase for 1975 and the long-range development phase for the year 2000, will be recommended for approval by the President and the Congress. Specifically, the initial action phase of the comprehensive plan will be recommended for such additional studies as required to support the request for needed authorization and appropriations by respective Federal, State, local government, or private interests.

3. Each of the functions enumerated in the authorizing Act, such as the previously mentioned pollution abatement and public health aspects, will be treated as a primary function and will be integrated into the final comprehensive plan. In the treatment of the function on industrial development, we do not propose to designate a specific

type of industry at a specific location, but will present the inventory of resources in the specific basin and sub-basin areas. Public health studies will be oriented toward determining the effect upon public health associated with the development of land and water resources. Because of the limited areas involving salinity, our studies for this function will be limited to an evaluation of the salinity problem.

4. The final or recommended plan with the initial action phase for the year 1975 will include estimated costs and benefits, cost sharing and reimbursement formulas where appropriate, and net public benefits. (I should like to point out here that we are not talking in terms of benefit-cost ratios. Where possible, we intend to list monetary benefits and costs to the fullest extent possible. Where intangible or institutional factors play a major part in the consideration of an element of the over-all final plan, we will cite benefits and costs in narrative form as a stimulus to local interests—an ingredient which all future planning must have if it is to be acted upon and not placed on a shelf merely as a dust-catcher.)

5. The final plan will both recognize and protect the rights and interests of the States in determining the development of land and water resources and the preservation and protection of existing, authorized and formally proposed works and programs of either Federal or non-Federal authorizations. (We have found from those within our area of study who are most concerned that the Commission will not affect projects or programs either underway or scheduled for a beginning before the final report of the Commission is published. However, we may well suggest proposed modifications for existing, authorized, and formally proposed projects and programs. But, such modifications would be limited to those found desirable, feasible, and consistent with the study objectives.)

6. Recommendations, in accordance with the Act, will be made specifying the manner by which a continuing or periodic review of the final comprehensive plan may be made to keep it not only current, but to prepare a basis for subsequent action phases. (Actions in the way of implementation certainly will speak louder than the words contained in the final plan.)

Practically every successful water or land use project, single or multipurpose, has considered water quality, to some extent, in the planning stage. This is so because of the effect of pollution on water quality. I speak of water pollution in its broadest sense—the introduction of deleterious substances resulting from man's activity into surface and ground waters. These substances come from our homes, farms, factories, mines, and industries. The true significance of these deleterious substances cannot be ascertained until their concentration and water uses are known. Pollution control is not an end unto itself but is a service-type activity brought into being by the needs of users for water of a specified quality. Because of the complex nature and the broad implications of pollution control, water quality should be considered throughout project formulation.

There are two fundamentals to be kept in mind in applying pollution control to resource planning: (1) both surface and underground waters ultimately receive and carry away our liquid wastes, and (2) all receiving waters have some ability to assimilate wastes. These fundamentals provide a rational approach to pollution control and will minimize costs of abatement.

How great a factor of safety should be allowed in using the streams' assimilative capacity? I do not have the temerity to give a finite answer, but I suggest that it only be used to a point where, if the pollution load is increased, additional pollution abatement measures could be operative before damages to existing water use would occur.

What I have been saying in essence is that pollution control should be planned and operated to meet all practical water quality needs. Many think that is what we have been doing for the past 50 years. They are partly correct, but note I said all water needs. I think you will find a great many instances where certain water needs have been ignored. If you will include, as I do, esthetic enjoyment as a need, you will not have to go very far to see an example of esthetic violation of one of the nation's most beautiful streams. The needs for esthetic satisfaction from our surface waters suggest that we need a minimum floor under our pollution control efforts. As a minimum, no waste should be allowed to make a surface water unsightly, malodorous or unhealthy, unless in the planning process economic and reasoned judgment based on a knowledge of all pertinent facts dictates to the contrary. In passing, some of the other contributions to multi-purpose planning by the pollution control technologists are the recovery of valuable by-products from liquid wastes, the relative location of water diversions to waste discharges, the recycling and reuse of waste waters, and the establishment of needs for dilution water.

Recognizing that planning is an essential element, I submit that river basin and multi-purpose planning should include the following criteria:

1. A master plan for the conservation, utilization, and development of land and water resources to be cooperatively developed by private, State, interstate, and Federal groups.
2. The master plan should be up-dated periodically or kept current on a continuing basis.
3. The governing bodies of all political subdivisions should recognize their interest and responsibility for planning.

**4. Legislative bodies must establish necessary legal authority for cooperative resource planning work.**

5. Details of planning for resource development should be done by the lowest practical political subdivision.

6. Costs of resource development should be equitably shared by the beneficiaries.

I have outlined the criteria that I believe are essential to comprehensive river basin and multi-purpose planning. These criteria take cognizance of the growing competition for water and if properly applied bring the pollution control problem into focus. I commend the Study Commission approach and organization to all of you who are interested both in comprehensive development and also in the often-neglected water pollution aspects.

In the Southeastern area, generally and taken as a whole, we have been blessed by a plentiful supply of water. Concentrations of urban population, however, already are forewarning us that the talents of man must be directed towards the proper planning and protection of this natural resource for the future.

Without such planning and timely implementation, today's complacency will become a stampede of hasty action. The result inevitably will be costly, far more so than the investment today, in an energetic, diligent, and thorough creation of a comprehensive plan based on the preservation and most efficient use of that which the Almighty has provided.

**Dr. ACKERMAN.** I would just like to note in connection with Mr. Woodruff's fine paper that we are slowly moving ahead in this country on this matter of comprehensive development and comprehensive planning. We have moved fairly far on the Columbia, the Central Valley, and now, of course, the large California State Water Plan. We have plans on the Missouri which are being implemented. We have plans on the Colorado River Basin which are being implemented. Studies, such as the one Mr. Woodruff has been describing as now in process in the Southeast, have been undertaken in the New England-New York area and completed, and also in the Arkansas area. A similar study is in progress in Texas, and I think a study somewhat farther along is going on in the Delaware Basin.

Now, this is a substantial part of our country, represented by the several basins, several of which are quite large.

This, I think, has some meaning, in fact, a good deal of meaning, as Mr. Woodruff suggested, in the matter of control, because it means that we are getting now for the first time for these basins some clear idea of what total needs of these basins will be in the future as we can foresee them at this time. And, more than that, we are setting up something of a structure by which we can continue to adjust and revise our impressions of those needs. And, further, we are getting an idea as to the alternative sources of water which exist in those basins to meet the needs, and therefore a framework on which we will judge the question before this panel, that is, the central question.

## DISCUSSION

### Eugene W. Weber

***Special Assistant to the Director of Civil Works***
***Office of the Chief of Engineers, Department of the Army,***
***Washington, D.C.***

Mr. Woodruff has presented an excellent summary of the approach to river basin planning being used by the U.S. Study Commission—Southeast River Basins and has indicated the inter-relation of pollution control and planning to meet all water needs. His presentation is most useful and timely. It highlights the need for coordinated, comprehensive planning for optimum conservation, development and use of our resources especially now that we are passing from an era of generous supply of water and other resources in relation to needs, and are entering a phase where the demands are such as to require the utmost in efficiency and ingenuity to insure that there will be enough usable water to go around.

Mr. Woodruff points out that in accordance with the intent of the authorizing legislation, the Southeast River Basin studies will include consideration of both land and water resources, with equal emphasis on the land and water functions, and with all functions having a co-equal status. This presents a real challenge. To consider the needs for all uses of land and water resources and plan for optimum solutions in meeting those needs requires consistency in the procedures used for analyzing each land and water function. We have made progress in achieving such consistency among some of the land and water functions but we desperately need improved analytical and evaluation methods for all land and water uses to realize the goals in coordinated land and water planning.

Giving equal consideration to all land and water functions in formulating plans also involves equal obligations for those functions. This approach is not a one-way street. For example, when we consider using reservoir storage space for flood control purposes, we must consider the relative value of that space for other possible needs, such as water supply. This in turn requires evaluation of functions on a comparable basis and consideration of available alternative solutions.

Another "obligation" that stems from co-equal status is that of sharing the responsibility for planning and financing various functions by the Federal, State, and local governmental and private interests involved. The responsibility of each of these groups is different for the various functions under consideration. It is not essential that there be equal responsibility for all functions but the sharing of effort and cost should be consistent with the interest and responsibility. Unfortunately our laws and customs do not define these responsibilities completely or consistently. We need such definition for properly coordinated river basin planning and for effective implementation of those plans.

The combination of regional and national viewpoints in the Southeast River Basin planning program also presents a challenge. Ideally, we should produce plans under which net benefits would be maximized from a national viewpoint. However, this would require adjustments between regions and communities that would involve considerations difficult to reflect in the formulation and evaluation of alternative plans. As a practical matter, therefore, regional and local viewpoints must be taken into account. Perhaps this can be done with the least compromise of the ideal by favoring those developments which have outstanding advantages from regional and local standpoints and, at the same time, have little or no disadvantage from the national viewpoint.

This same point has significance with respect to the flexibility we try to build into our plans. Long-range river basin plans involve so many projects and so many functions that they tend to present flexibility to the point of aimlessness. Here, again, the ideal solution, nationwide, would be to undertake the most efficient projects first in order to maximize net benefits in use of resources. However, this would probably not result in consistent or equitable development of resources to meet needs from a regional or local viewpoint. Again from a practical standpoint, plans can take these regional or local considerations into account by providing for early scheduling of development in each region of those projects that are most desirable and most efficient from the regional or local point of view and which, at the same time, involve little or no conflict with alternatives in other areas.

By means of these practical considerations we can provide our long-range plans with a hard core of priority developments and reduce the number of alternative plans for later development to a workable range which still has flexibility but which is not purposeless.

Comprehensive river basin planning such as that now under way in the Southeast River Basins brings out clearly the increasing interdependence of the various purposes of land and water resource development. For example, the demand for recreational use of water bodies is related to population growth and economic conditions which, in a given situation, might depend largely on availability of water for industrial purposes. The feasibility of both the recreational and water by the Federal, State, and local governmental and private interests involved. The responsibility of each of these groups is different for the various functions under consideration. It is not essential that there be equal responsibility for all functions but the sharing of effort and cost should be consistent with the interest and responsibility. Unfortunately our laws and customs do not define these responsibilities completely or consistently. We need such definition for properly coordinated river basin planning and for effective implementation of those plans.

The combination of regional and national viewpoints in the Southeast River Basin planning program also presents a challenge. Ideally, we should produce plans under which net benefits would be maximized from a national viewpoint. However, this would require adjustments between regions and communities that would involve considerations difficult to reflect in the formulation and evaluation of alternative plans. As a practical matter, therefore, regional and local viewpoints must be taken into account. Perhaps this can be done with the least compromise of the ideal by favoring those developments which have outstanding advantages from regional and local standpoints and, at the same time, have little or no disadvantage from the national viewpoint.

This same point has significance with respect to the flexibility we try to build into our plans. Long-range river basin plans involve so many projects and so many functions that they tend to present flexibility to the point of aimlessness. Here, again, the ideal solution, nationwide, would be to undertake the most efficient projects first in order to maximize net benefits in use of resources. However, this would probably not result in consistent or equitable development of resources to meet needs from a regional or local viewpoint. Again from a practical standpoint, plans can take these regional or local considerations into account by providing for early scheduling of development in each region of those projects that are most desirable and most efficient from the regional or local point of view and which, at the same time, involve little or no conflict with alternatives in other areas.

By means of these practical considerations we can provide our long-range plans with a hard core of priority developments and reduce the number of alternative plans for later development to a workable range which still has flexibility but which is not purposeless.

Comprehensive river basin planning such as that now under way in the Southeast River Basins brings out clearly the increasing interdependence of the various purposes of land and water resource development. For example, the demand for recreational use of water bodies is related to population growth and economic conditions which, in a given situation, might depend largely on availability of water for industrial purposes. The feasibility of both the recreational and water supply uses in turn is affected by the quality and condition of the water and may be heavily dependent on the status of pollution control in the area.

The growing importance of pollution control in relation to the problem of meeting both existing and future demands for water is illustrated clearly in several of the reports recently prepared for the Senate's Select Committee on National Water Resources. Two points are particularly significant: First, even with very complete treatment of wastes at the source, which must certainly remain a prime objective, in fact, our first line of defense, the prospective load on our streams will seriously impair our ability to provide enough water of suitable quality for many purposes; second, there does not appear to be, at this time, any practical way to avoid using many of our streams for waste residuals after treatment.

These prospects highlight the need for coordinated planning of pollution abatement and the conservation and use of water for the many purposes for which it is needed. Sufficient dilution water to keep streams usable for various purposes is now a definite requirement.

In the past, storage regulation to improve low water flows has been recognized as a desirable supplementary pollution abatement measure in a few instances where practicability of direct waste treatment has been limited by technological, economic, or other considerations. In the future, a combination of direct treatment and low flow regulation may prove to be the optimum solution in an increasing number of situations.

This has several significant implications in future river basin planning. In the broadest sense, it means that we must seek a proper balance in all, rather than some, of the inter-related aspects of our plans for use of land and water resources. Maximizing net benefits from the standpoint of one or only a few of the prospective uses for these resources will not be sufficient. A high degree of utilization of certain lands or of available stream flow for specific purposes which may appear to be highly justified can lead to adverse effects on uses of resourses for other purposes. The optimum solution requires maximizing net benefits across the board rather than on a spot basis.

Comprehensive river basin planning such as that under way in the Southeast Basins affords an opportunity to approach the problem in this broadest sense but there are many difficulties to be overcome. One of the greatest needs is for classification of streams or establishment of water quality objectives, preferably in conjunction with zoning or regulation of land use, all designed to provide for the most effective use of land and water resources to meet anticipated needs. Also, we must find ways to evaluate alternative and competing uses of resourses on a comparable basis. If low flow regulation is to be taken into account adequately in planning for a properly balanced use of resources, not only are evaluation procedures necessary but Federal legislative and administrative policies must be established and the role of non-Federal interests defined.

We hope that real progress can be made on these problems in coming months in order that river basin planning and pollution abatement measures can contribute in the best possible way towards meeting needs for water of suitable quality in sufficient amounts at the right time and place. The valuable information recently assembled for the Senate's Select Committee on National Water Resourses and the enlightenment resulting from such deliberations as this National Conference on Water Pollution should be utilized by all concerned to that end.

**Dr. ACKERMAN.** We have, unfortunately, our first casualty to the weather. Senator Clair Engle was to have been the second discussant of Mr. Woodruff's paper. I regret personally his absence a good deal, because Senator Engle has been very much interested, I think almost from the beginning of his career, in water development, and has been an able spokesman for causes of conservation, and particularly for Western water development.

However, we do have an able substitute in Mr. Philip Dickinson, who is technical assistant to Senator Engle. Mr. Dickinson is a rather rare individual, in that he is both a professional engineer and a professional journalist, and he has practiced both professions. So he really has been a bona fide journalist and a bona fide engineer, having served in the Bureau of Reclamation and abroad.

Mr. Dickinson will present Senator Engle's comments.

**Mr. DICKINSON.** Mr. Chairman, ladies and gentlemen: I wish to express Senator Engle's regret that he didn't make it back here from California due to difficulty in getting a plane last night. He may get here tonight, but that will be too late.

I want to emphasize that although Dr. Ackerman has introduced me as a water resource engineer, which I am, nevertheless I am speaking today for Senator Engle.

## DISCUSSION

### Hon. Clair Engle

***United States Senator***

I want to compliment Mr. Woodruff on his clear exposition of how the growing competition for water is being anticipated in the Southeast River Basins by careful multipurpose planning. And I want to endorse his basic conclusion that planning is cheap—in fact, profitable—when we consider the costly investments that are required for the conservation and devlopment of our water resources.

The thing I wish to emphasize here is the prime importance today of the *river basin approach.* Multipurpose planning by itself is not enough. The 11 functions listed by Mr. Woodruff in the Southeast Commission's study all require consideration; but I submit that they must be considered collectively in relation to over-all conditions of water supply, water requirements and the impact of project development in every part of the river basin, including the main stream and all its tributaries. In other words, functional coordination must be accompanied by geographical coordination.

The reason for this is quite simple: water runs downhill. Rivers follow geographic boundaries rather than political boundaries. They flow unimpeded across State or provincial lines. For that reason water resource development is properly planned along natural river basin lines rather than along man-made political lines. The geographic river basin, including every tributary from the mountains to the sea, is the proper unit for planning water resource development.

Of course this approach does not end with planning. It is followed naturally, I think, by an orderly long-range schedule of project construction and, in turn, by fully integrated operation of all projects within a major river basin in order to achieve maximum multi-purpose benefits at minimum cost.

In this connection it should be observed that the monetary benefit-cost ratio of individual projects may not always be the best test of feasibility. For one thing, as Mr. Woodruff has pointed out, intangible factors such as social stimulus and esthetic enjoyment merit evaluation. For another, certain small units that cannot stand by themselves, often can be well justified as parts of a basin-wide whole. This is a principle that has been successfully established in the Central Valley Project in California.

Parenthetically, I would like to observe that, although I greatly admire the operation of the Tennessee Valley Authority, the independent basin authority is not the only organizational concept by which basin-wide planning and development can be managed. Interstate compacts constitute one device of merit. The basin commission system of Federal, State, and local coordination described by Mr. Woodruff is another.

Finally, I suggest that the function of water pollution control in which the delegates to this Conference are particularly concerned, is one that especially calls for consideration on a river basin basis. The urgency of this approach was demonstrated during the last Congress at the field hearings conducted by the Senate Select Committee on National Water Resources, of which I am a member. In all of the populous eastern States, witness after witness told about local water supply difficulties and river problems created by the increasing general use of rivers and their tributaries as municipal and industrial sewers. Prominent examples of this situation are the Connecticut River, the Delaware, the Susquehanna, and the Potomac—all flowing through or between several States. The water pollution problem is basin-wide, not just State or local. Cleaning up our rivers, from their source to the sea, will be one of the most important resource jobs facing this Nation in the next decade.

# Effects of Land Use and Treatment on Pollution

CARL B. BROWN
*Watershed Program Specialist*
*Office of the Assistant Administrator for Watersheds*
*Soil Conservation Service, Department of Agriculture*

It is a real privilege to have this opportunity to participate in the National Conference on Water Pollution. The topic assigned to me concerns the effects of land use and treatment, primarily for agricultural purposes, on the pollution of our rivers and streams. Hoak (*8*) has defined pollution as "the discharge of material that unreasonably impairs the quality of water for maximum beneficial use in the over-all public interest." Within this definition I shall try to cover briefly the types of pollution that are caused by inorganic suspended and dissolved solids in our rivers and streams which result from improper land use and treatment.

Silt pollution is the most common form of such pollution. We are using silt here as a layman's term to mean the inorganic solids transported by a stream either in suspension in the current or moving along the stream bed. Technically, of course, silt is composed of solid particles larger than clay and smaller than sand and gravel. Actually, particles of this size do comprise most of the solids moving in those streams where silt pollution is generally the most serious problem.

Our consideration will include the adverse effects of silt pollution, the quantities and distribution of such pollution, and the extent to which it results from improper land use and destructive agricultural or other practices such as those common in urban construction. As a part of this discussion we shall consider briefly pollution by dissolved salts or salinity, a problem which, insofar as it relates to agriculture, is largely confined at this time to streams in the Western States affected by seepage and drainage from irrigated lands. Finally, we will discuss the control of silt pollution and salinity by soil conservation, forest management, and watershed protection measures.

### The Adverse Effects of Silt Pollution

Silt pollution is nearly always detrimental to the beneficial use of water. Moreover, it often causes extremely critical problems where the silt deposits as the velocity of streamflow is reduced. Silt pollution causes seriously adverse effects on nine segments of our national economy. These are (1) public health, (2) public water supply, (3) fish and wildlife and recreation, (4) valley agriculture, (5) drainage, (6) irrigation, (7) flood control, (8) waterway commerce, and (9) hydropower production. Estimates made 35 years ago (*1*) showed an average annual loss of some $175 million from silt pollution and sedimentation. Considering the rapid expansion in all forms of water use since that time the annual losses may now be as much as double this figure.

The nature of these various damages has been fully documented. (*1, 2*). Time available here will not allow even brief reference to most of them. It is now widely recognized, however, that silt pollution is a major deterrent to the most effective development of the water resources of most drainage basins in the United States.

We living here in the Washington Metropolitan Area are acutely aware of this. In a comprehensive study made for the Interstate Commission on the Potomac River Basin in 1957, Wolman, Geyer, and Pyatt (*14*) flatly state:

> For people living in the Washington Area, silt is the worst pollutant of the Potomac River. Practically all of the silt brought down from the 12,000 square mile drainage area settles in the tidal estuary of the Potomac River in Washington. This silt blankets the bottom, smothering life and filling the basin at a rate which should cause deep concern. * * * The silt problem is of such magnitude that its solution should take precedence over all other pollution control activities in Metropolitan Washington. If this problem is not solved; if the River is left to fill with sediment, efforts to develop the recreational uses of the Potomac River in Washington will be almost fruitless.

Of the many different aspects of silt pollution which might be described, its effect on public water supply may be of greatest interest to this group. In round figures some 2,000 billion gallons of water are filtered annually in the United States to remove suspended silt.

Some 20 years ago the Soil Conservation Service made a study (*3*) of the effects of silt pollution on water filtration in 22 cities in the Piedmont area of North Carolina. This study showed that the average cost of water treatment, including overhead and amortization of plant and equipment, was $70 per million gallons, of which cost $27 was for treatment purposes and $5 for chemicals (mainly alum used to cause the finer silt particles to settle out). This study showed that a 30-percent reduction in the silt load of streams in this region—a very modest expectation from an adequate soil conservation program—would result in an average immediate saving of $1.50 per million gallons. Considering the future savings from smaller capital outlay for new settling basins and plant equipment, reduced flushing costs and other plant operations, the total savings eventually was estimated to be $7 per million gallons. Increasing costs of water treatment since 1940 have probably at least doubled these values.

Over and above this treatment cost is the damage from silting to the Nation's water-supply reservoirs. About 25 percent of our population now depends on surface water storage in more than 3,000 major reservoirs. We estimate that the siltation of these reservoirs resulting mainly from soil erosion on watershed lands is destroying enough storage capacity every year to meet the water-supply needs of a city of a quarter million people.

### Quantity and Regional Distribution of Silt Pollution

Sedimentation surveys have been made of more than 700 storage reservoirs and farm ponds (*10*) and sediment load measurement stations have been maintained on about 1,200 streams in the United States (*6*). Although much of the voluminous data is unpublished, a few rough approximations can be made from it.

The Mississippi River, which drains about half of continental United States, carries an estimated average annual silt load of 500 million tons into the Gulf of Mexico (*9*). All of the rest of the rivers of the United States combined carry about an equal amount (*7*). The estimated one billion tons of annual silt load entering the oceans every year, if compacted to a weight of 100 pounds per cubic foot, are enough to cover the 69 square mile District of Columbia more than 10 feet deep in mud every year.

Silt entering the oceans is not, however, a measure of the silt pollution problem. Rather it is the silt carried in the water flowing down our streams that must be considered in the use of the streamflow. It is estimated, in fact, that only about one ton in four of the silt produced by erosion on our watersheds ever reaches the ocean. The other three tons are deposited in our storage reservoirs, on our fertile flood plains, and in our harbors and estuaries. Millions of tons of it have to be filtered from our domestic and industrial water supplies every year.

The silt load carried by rivers varies widely from stream to stream and from region to region.

Two types of regional differences are significant. One is the average silt concentration in the flow, usually expressed in parts per million.

The other is the total silt load of the streams which can be compared regionally in tons transported annually per square mile of drainage area. The former is a more appropriate index in considering the cost of filtration, while the latter is of more significance in evaluating reservoir or harbor silting.

Maximum daily concentrations of more than 130,000 p.p.m. have been recorded on the Colorado River at Grand Canyon, more than 210,000 p.p.m. on the Rio Grande, and more than 270,000 p.p.m. on small streams in Iowa. However, most of the large streams of the country seldom have concentrations exceeding 10,000 to 30,000 p.p.m. and most streams east of the Mississippi never approach these values. But the silt load of Southwest streams as a whole measured in tons per square mile per year falls far below that of many other major regions, simply because this generally arid area produces so much less water yield per square mile.

Geiger (*4*) has shown that on the basis of average annual silt load in tons per square mile, the highest producing areas of the Nation are the South Atlantic and Gulf Coastal Streams, the short tributaries of the Mississippi below the Ohio, the lowest Missouri tributaries below Sioux City, and the Mississippi River tributaries below St. Paul. Values for smaller streams in these areas range from 260 to 9,000, with an occasional maximum up to 30,000 and averages from 3,000 to 5,500 T/sq. mi./yr. Areas of medium sediment production include the Ohio Basin, the eastern Great Plains, and the California drainage basins, with averages of 1,000 to 2,200 T/sq. m./yr. The lower producing areas are the North Atlantic, Great Lakes, High Plains, Rocky Mountains, and Pacific Northwest drainage basins, with averages of 165 to 1,000 T/sq. mi./yr.

## Sources of Silt Pollution

The sources of silt pollution are of considerable consequence in considering the feasibility of its abatement. The principal sources fall into seven groups, namely, (1) sheet erosion from the land surface, (2) gully erosion, (3) stream channel erosion, (4) mass movements, (5) flood erosion, (6) construction erosion, and (7) mining and industrial wastes. This classification makes no distinction between normal geological erosion and man-induced erosion. Sheet erosion and gullying have always occurred on sparsely vegetated land in arid or semi-arid regions and along meandering stream channels, even in humid regions. The concept of "accelerated" erosion, however, implies a man-induced change resulting primarily from depletion of the vegetative cover and use of the land for cultivation or other purposes that leaves it periodically or continuously exposed to erosion from water runoff.

Glymph (*5*) has summarized the results of studies of silt sources on 113 watersheds ranging in size from 23 acres to 437 square miles in 15 States from New York to California. He shows that sheet erosion accounts for 90 percent or more of the silt production in half of these watersheds and 50 percent or more in 79 percent of the watersheds.

Sheet erosion generally produces a major part of the silt load of our rivers over broad areas that are used mainly for agriculture and have more than 20 inches of precipitation. In most forest and range country and areas of less than 20 inches of precipitation, on the other hand, gullying and stream channel erosion generally furnish the greater part of the total silt load. In small watersheds, of course, any of the seven principal classes of erosion may be the predominant cause of silt pollution.

A vast amount of research on erosion rates by the Department of Agriculture over the past 25 years has enabled the development of comparative scales of the relative amount of sheet erosion under different agricultural use and treatment of land. These data show that the clearing of forests and continuous use of land for row crops increase erosion from 100- to 10,000-fold. Plowing up grassland for continuous row crop cultivation increases erosion 20- to 100-fold.

Although agricultural use of land is by all odds the dominant source of silt pollution in those parts of the country where population is concentrated, other sources are locally of considerable significance. One of these is erosion from construction operations which has been greatly increased in the past 15 years in our exploding metropolitan areas. Because this source of pollution is often so close to points of water use, its relative importance is significantly increased.

In Rock Creek here in the District and adjacent Maryland, flash floods and silt pollution have been increasing for years as a result of suburban expansion. Its valley, which is mostly in public ownership, forms the largest recreational area and park in the Washington Metropolitan Area.

By 1957 this once predominantly rural drainage area had become 56 percent urban. Urbanization is still on the increase. Our studies indicate that if urbanization of the whole watershed is accomplished, 27 percent of the area would be in impermeable cover such as houses and streets and 73 percent in permeable cover. At present about 750 acres are under construction each year. The average period of abnormal erosion resulting from construction is about three years.

The rate of erosion for an area under construction is some three to six times the average rate for a rural agricultural area. Once grading, seeding, and paving is completed, however, erosion will decline to a stable rate comparable with that from pasture areas.

### Salinity Pollution

Another important aspect of water pollution is the content of soluble salts. The effects of the variety of kinds and amounts of salts in stream water differ materially. Some salts such as calcium make water hard and impair its use for domestic purposes, yet these same salts can be helpful in irrigation water. Other salts, particularly sodium, cause trouble in water used for irrigation.

Water quality criteria from the viewpoint of soil and plant relationships differ in many respects from the criteria for domestic or industrial use. The total concentration of soluble salts, the concentration of sodium, and the proportion of sodium to calcium plus magnesium, as well as the occurrence of minor elements such as boron, are important in determining the quality of irrigation water. When water high in salts is used for irrigation purposes, the soil may deteriorate to the extent that it can no longer be used to produce satisfactory crops.

The salt content of most irrigation waters ranges approximately 70 to 3,500 parts per million. The common use of 2 to 4 acre-feet of water per acre to produce crops under irrigation in our Western States can mean that up to 10 to 20 tons of salt are placed on each acre of irrigated land during each growing season.

Most of the rivers emerging from the Western mountains contain very little salt originally but pick up large quantities of soluble salts as the wasted water passes through the soil profile and returns to the stream. It has been estimated that from 50 to 75 percent of the water diverted on many irrigation projects is lost by seepage in canals and on the farms. This wasted water returns to the streams and is often used over and over again, but with each reuse the quality is generally impaired.

### The Control of Silt Pollution and Salinity

This brings us to the crux of the problem, what can be done to diminish or control silt pollution and man-induced salinity in water? Effective methods for achieving these objectives have been developed and are already being widely adopted in agricultural areas of the United States.

Abundant research data give a basis for estimating the potential reductions that might be achieved by practical application of existing knowledge. For example, analysis of rainfall intensity and frequency by months in any area gives a basis for planning maximum protection of the soil surface by cover crops, mulches, etc., in those months when the erosion potential from rainfall is greatest. The effects of length and degree of slope on some soils indicate the relative need for measures such as terraces, diversion ditches, strip crops, and benching to reduce the effective slope and break it into shorter lengths. Measurement of inherent differences in soil erodibility shows adjustments of land use needed to afford greater vegetal protection of more erodible soils and more use of less erodible soils for row crops. It indicates also possibilities for reducing the erodibility by changing the soil structure through tillage practices and by plowing under cover crops, mulches, and manure.

Experiment station data have shown, for example, that a good 3- or 4-year rotation will reduce sheet-erosion loss to 14 to 45 percent of that occurring under a one-crop system of clean cultivation. Contour farming, strip cropping, and terracing practices applied to various soils, slopes, and with different amounts of rainfall effect reductions ranging from 10 to more than 90 percent.

Other conservation practices such as (1) the use of stubble mulch, (2) grassed waterways, (3) planting steep slopes to grasses and trees, (4) proper pasture and range management, and (5) improved wildlife areas, especially pond areas where fish are raised, keep silt in place and help prevent erosion.

Other types of erosion may require special forms of treatment. Stabilization of major gullies, valley trenches, or streambanks, for example, may be accomplished in some places by planting of trees and vines; or they may require small dams, revetments, jetties, or other control structures. It is physically possible in areas of more than 20 inches of rainfall to stabilize completely most gullies and virtually eliminate them as a source of sediment. In areas of less than 20 inches of rainfall, more reliance must be placed on structural measures such as revetments, check dams, and debris basins. Floodwater-retarding structures are effective in holding back as much as 90 percent or more of the silt originating on watershed lands above them. Economic rather than physical considerations primarily govern the amount of reduction in silt pollution that can be achieved in most watersheds.

In the Western States it has been found that conservation irrigation practices such as canal lining and more efficient application of water on the farm materially reduce the soluble salts getting into streams.

The over-all effect of soil and water conservation programs on sizable watersheds has been evaluated in many parts of the country. For example, a study was made by the Soil Conservation Service in 1954 of daily turbidity records at five municipal waterworks plants in Georgia. At Atlanta, Columbus, Macon, Milledgeville, and Augusta, the turbidity records all told the same story—a steady downward trend in turbidity between 1934 and 1954. Atlanta, which obtains its raw water from the Chattahoochee River, showed a reduction from an average 400 p.p.m. in 1934 to an average 76 p.p.m. in 1953.

Without exception, the local waterworks men agreed that the reduction in turbidity was due to the cumulative effect of soil conservation work in the respective watersheds during the 20-year period.

A similar conclusion has been reached from repeated reservoir surveys in many parts of the country.

In a recent report (*12*) to the Senate Select Committee on National Water Resources, the Department of Agriculture estimated that application of present conservation programs at the current level of intensity to 80 percent of the upstream watersheds now feasible of treatment would reduce sediment concentration in streams from 30 to 75 percent in those major river basins classified as having high to very high relative rates.

The means of achieving greater control of silt pollution and salinity are available and need only greater implementation. With the know-how at hand the control of soil erosion on public lands, Federal, State, and local, is simply a matter of making the necessary financial resources available.

On privately owned lands the problem is somewhat more complex because its solution depends on millions of decisions by private landowners and operators as to their use, treatment, and management of their lands. Most of the needed administrative machinery has been created, however, to give every encouragement and help to these private landowners and operators as well as to local communities to aggressively attack this problem. This machinery includes:

1. Soil conservation districts which are local units of government, formed by landowners and operators under provisions of State enabling legislation in every State and Puerto Rico. Their specific objective is soil and water conservation, application of the very practices required to control silt pollution. Their formation began in 1937. They now number 2867, contain about 1.7 billion acres or 91 percent of the agrucultural area of the United States. More than 1,800,000 farmers and ranchers operating over 1 billion acres now cooperate with these districts. The districts are provided with technical assistance by the Soil Conservation Service to help farmers and ranchers plan and apply needed conservation practices. Many States also appropriate funds to assist these districts.

2. The Agricultural Conservation Program of the Department of Agriculture provides cost-sharing payments to farmers and ranchers for conservation practices installed by them.

3. Loans for conservation work are available from the Farmers Home Administration in the Department.

4. The Forest Service and cooperating State forestry agencies assist farmers on woodland management practices.

5. The Federal-State Extension Service provides educational assistance in encouraging farmers to adopt conservation practices.

6. A comprehensive planned attack on silt pollution on a watershed basis is possible through cooperation of local, State, and Federal agencies and groups under the provisions of the Watershed Protection and Flood Prevention Act, Public Law 566 (*11*). This program adds to the assistance of all other programs the further help needed to accelerate the application of land treatment measures and to install structural works of improvement which are too large for individual landowners to install.

Under Public Law 566, passed by the Congress in 1954, local organizations can initiate a project on watersheds up to 250,000 acres in size. Federal help is not given until the project is approved by the responsible agency of State government. The Federal government's contribution includes (1) technical assistance in planning, designing, and installing land treatment and structural works of improvement, (2) sharing certain costs, and (3) extending long-term credit to help local interests bear their share of the costs.

Watershed projects under this act provide for (1) soil and water-conservation treatment of all the land in the watershed, (2) floodwater-retarding structures and other measures needed for flood prevention, (3) improvements for agricultural water management, such as irrigation and drainage, and for non-agricultural water management such as municipal and industrial water supplies and fish and wildlife development. This program can provide one of the most effective means of achieving silt pollution control.

### Recommendations

Four recommendations merit consideration by this Conference. These are:

1. Silt pollution should be recognized as a major impairment of the "quality of water for maximum beneficial use in the over-all public interest." As such, it should be accorded equal consideration with inorganic pollution by sewage and industrial wastes in programs for pollution abatement and control.

2. Existing Federal, State, and local programs for soil and water conservation and watershed protection which are highly effective in the control of silt pollution should be further strengthened to achieve such control at a rate commensurate with the rapidly increasing demands on our national water resources.

3. Legislative action should be taken to provide for more adequate coordination and integration as well as implementation of all forms of pollution control in all types of river basin development, including the small watershed program authorized by Public Law 566.

4. Research needed on some aspects of silt and salinity pollution control should be accelerated. This includes acceleration along the

lines proposed by the Secretary of Agriculture in his recent research needs report to the United States Senate. (*13*) Research is also urgently needed on the control of construction erosion in expanding urban areas.

1. Brown, Carl B., 1948. *Perspective on sedimentation.* Proc., Federal Inter-Agency Sedimentation Conference, pp. 3-7, U.S. Govt.
2. Brown, Carl B., 1950. *Effects of soil conservation.* Chapter in Trask's applied sedimentation. John Wiley & Sons, Inc.
3. Garin, Alex, 1940. *Effect of soil erosion on the cost of public water supply in the North Carolina Piedmont.* U.S. Soil Conservation Service, SCS-EC-1 [processed].
4. Geiger, A. F., 1958. *Sediment yields from small watersheds in the United States.* Extrait des comptes rendus et rapports—Assemblée Generale de Toronto 1957 Tome I, pp. 269-276, Gentbrugge.
5. Glymph, L. M., Jr., 1957. *Importance of sheet erosion as a source of sediment.* Symposium on watershed erosion and sediment yields. Trans., Amer. Geophy. Union, vol. 36, no. 6.
6. Gottschalk, L. C., 1958. *Predicting erosion and sediment yields.* Extrait des comptes rendus et rapports—Assemblée Generale de Toronto 1957 Tome I, pp. 146-153, Gentbrugge.
7. Gottschalk, L. C. and Jones, V. H., 1955. *Valleys and hills, erosion and sedimentation.* Water, the yearbook of Agriculture, pp. 135-143, U.S. Govt. Ptg. Off., Washington, D.C.
8. Hoak, Richard D., 1953. *Water supply and pollution control.* Sewage and industrial wastes, vol. 25, pp. 1438-1449.
9. Holle, C. G., 1952. *Sedimentation at the mouth of the Mississippi River.* Proc., 2nd Congress on coastal engineering, Univ. Calif., pp. 111-129.
10. Inter-Agency Committee on Water Resources, Subcommittee on Sedimentation. *Summary of reservoir sedimentation surveys made in the United States through 1953.* Sed. Bull. No. 6, 1957. U.S. Govt. Ptg. Off.
11. U.S. Department of Agriculture, Soil Conservation Service, 1959. *Small watershed projects under the Watershed Protection and Flood Prevention Act*, PA-392.
12. U.S. Senate, Select Committee on National Water Resources, 1959. *Estimated water requirements for agricultural purposes and their effects on water supplies.* Com. Print No. 13. U.S. Govt. Ptg. Off.
13. A Report of Findings by the Working Group Appointed by the Secretary of Agriculture, U.S. Department of Agriculture, January 1959. *Facility Needs—Soil and Water Conservation Research.* Sen. Doc. No. 59, U.S. Govt. Ptg. Off.
14. Wolman, Abel, Geyer, John C., and Pyatt, Edwin E., 1957. *A clean Potomac River in the Washington Metropolitan Area.* Interstate Com. on Potomac River Basin, Washington, D.C.

## DISCUSSION

GORDON K. ZIMMERMAN
*Executive Secretary*
*National Association of Soil Conservation Districts,*
*Washington, D.C.*

In his paper, Mr. Brown has ably reviewed the least spectacular and least controversial aspect of the water pollution problem. The polluting effects of inorganic silt moving into the rivers and streams of the country from both rural and metropolitan watersheds are not well known to the general public. There is a preoccupation, generally, with the damaging effects of municipal sewage and industrial wastes.

Silt is the stepchild of the Nation's pollution problem. Although it is the most important pollutant of all, from the standpoint of volume of material, it receives relatively little popular attention. The probable reason is that silt represents, in relation to other major forms of pollution, a smaller hazard to the public health.

Nevertheless, silt pollution and sedimentation merit far greater consideration than they have had to date in the Nation's over-all programs for pollution abatement and control. Economically, aesthetically, and in other ways, they represent a major water waste and a major impairment of water quality for maximum beneficial use.

Mr. Brown suggests the average annual loss from silt pollution and sedimentation may now be in the neighborhood of $350 million—double the estimate of 15 years ago. Even in these days of sky-rocketing costs, this is a sizeable figure. Much of this loss is assigned to the heavier costs of water treatment, increased investment in water works, and reduced storage capacity in water-supply reservoirs.

The economically-damaging effects of silt pollution, however, are widespread. In addition to the losses inflicted on public water supply, both the wash load and bed load of silt are costly—

1. In terms of public health, by adding to water treatment charges and by reducing the velocity of streamflow;

2. In terms of recreation, fish, and wildlife by shoaling streams and other bodies of water, impairing the clear water environment required by many desirable species of fish and wildlife; and by cutting the opportunities for swimming and boating;

3. In terms of waterway commerce, by shoaling of waterways and adding to costs of river and harbor dredging;

4. In terms of flood control and hydro-electric power production, by shoaling streams, displacing reservoir capacity, and adding to construction costs;

5. In terms of valley agriculture, by increasing the hazards of flooding and deposition;

6. In terms of irrigation, by reducing the quality of water; and

7. In terms of drainage, by cutting the capacity of drainage systems and the speed of water movement from the land.

It is worth noting that forces are present which will most likely accentuate the silt pollution problem in the years ahead.

In his paper, Mr. Brown listed seven of the principal sources or causes of silt. To over-simplify, however, I would like to emphasize two groups—(1) the accelerated or man-induced erosion in various forms taking place as a consequence of improper or overly-intensive use of agricultural lands, and (2) the construction erosion which occurs when substantial areas of raw earth are exposed to rain during highway, housing, airport, and other developments associated with urban expansion.

Both of these sources could enlarge in importance. To provide the food and fiber required by our expanding population, it is now estimated by the U.S. Department of Agriculture that our present area of cropland will be increased from the present 460 million acres to about 523 million acres within the next 40 years. Furthermore, the intensity of land use must be doubled. We must get twice as much production per acre. USDA estimates we will need today's production equivalent of 1,010,000,000 acres of cropland in the year 2000—and we will have only 523 million acres on which to produce it.

Unless the intensified use of cropland is accompanied by intensified conservation, the prospect of an increased silt burden is apparent. So far our record has been marked by steady but not spectacular progress. The combined efforts for soil and water conservation in the United States during the past 27 years have provided adequate protection against erosion and other forms of land damage for probably less than 30 percent of the Nation's farm and ranch lands.

Mr. Brown referred to "our exploding metroplitan areas" and pointed out that erosion from construction operations has been greatly increased during the past 15 years. Somewhat more than a million acres are now being exposed to rapid erosion as a result of construction processes during at least a part of every year. This silt source is likely to increase as construction work spreads and our metropolitan areas expand to accommodate the predicted population of 350 million at the turn of the century.

Construction erosion is a specialized problem for which we now have inadequate answers. There is a pressing need to find practical methods for dealing with it because, as Mr. Brown points out, it frequently occurs close to points of water storage and water use and its relative importance is thereby significantly increased.

For most agricultural areas of the country, however, methods of control are generally known and available—even though much remains to be done in terms of application. During the past 20 years, the existing local, State, and Federal programs for soil and water conservation and for watershed protection, have demonstrated that significant results can be obtained in diminishing the silt burden.

Additional and important help will be forthcoming in the years ahead from the new U.S. Sedimentation Laboratory at Oxford, Miss. Just beginning investigations on a 117 square-mile watershed, the laboratory will augment our basic knowledge about the sources and control of the silting process.

To refine and enlarge our present knowledge still further, it would be most useful if field studies could be set up in about 10 or 12 of the country's major soil problem areas. We need more precise data correlating the silt, yield from selected watersheds with the rainfall, land use, conservation treatment, soils, and physiographic aspects of such watersheds. With this kind of information, greater efficiency would become possible through regional and local variations in control measures.

In an over-all assessment of the silt pollution problem, however, the pressing need is for dollars rather than data. Certainly this is true on the nation's public lands, both State and Federal. Dollars are the prime consideration, also, in the speed with which government programs can provide assistance to private landowners.

# Pesticides and Water Pollution

Dr. Clarence Cottam
***Welder Wildlife Foundation***

Water, soil, air, and sunlight are the four basic ingredients that make life on mother earth possible. Accordingly, life is curtailed or handicapped to the extent that any of these basic requirements or substances are made unuseable or unavailable. Pollution abatement and clean water, therefore, have more than academic significance to an enlightened citizenry.

In the past, water conservation and development have been mainly concerned with water volume. Dams and related structures have been built, soil conservation practices have been undertaken, irrigation and flood control projects have been carried out and aqueducts and diversion structures have been installed to transport precious water from areas of abundance to areas of need. Water now is in short supply in many places and too often it is of poor quality; yet, the demands for good water are increasing sharply with no letup in sight. With our exploding population increases and constantly expanding industry, it becomes abundantly clear that more consideration must be given to water quality. Water needs can be met only by using the available supply over and over again. We must practice use without abuse. Pollution must be stopped.

## Chemical Pollutants

More than half a million organic chemicals have been made and described (*11*). A few dozen of them are accepted by the Food and Drug Administration as being safe for addition to food and beverages and many are listed with a zero or near-zero tolerance level for human consumption. New materials or compounds are being made much faster than the toxicity of known materials is being studied.

Most surface waters receive a large, variable, and anonymous load of organic chemicals. Only a minute fraction of the materials dumped or washed into surface waters could hope to qualify with the Food and Drug Administration as acceptable for addition to food and beverages. These pollutants of soil, water, and air are altering and adversely effecting the environment in which our people must live. Pesticides form an ever increasing part of this complex chemical picture. These materials are being widely used to accomplish a specific aim with an ever increasing degree of efficiency and wholesale effectiveness. Too frequently these controls are used with little regard for other values and the over-all effect on the environment with its complex biota.

Since World War II, the pesticide chemical industry has undergone a revolution. The principal insecticides used before the war were either inorganic compounds such as the arsenicals or the naturally occurring poisons like pyrethrum, rotenone, and nicotine. Copper sulfate, arsenic compounds, and related poisons were the principal herbicides used. The introduction of DDT and 2,4-D, in about 1943 to 1945, marked the beginning of a tremendous upsurge in the development of what is now a bewildering array of chemical pesticides. More than 90,000 pesticide products and formulations are now registered under the Federal Insecticide, Fungicide and Rodenticide Act (*38*).

### What is the Size of the Pesticide Industry?

The pesticide industry is growing by leaps and bounds and entomologists predict, and chemical manufacturers hope for, a fourfold expansion in use of pesticides during the next ten to fifteen years. Today, well over 12,500 brandname formulations and more than 200 basic control compounds are on the market. Most of the currently used pesticides were unknown even ten years ago. Furthermore, and contrary to the public interest, most new pesticides are decidedly more toxic, generally more stable, and less specific in effect than those of but a few years back.

We do not know the total production or consumption of all pesticides. The Stabilization Service (*28*) of U.S.D.A. shows that 574,213,000 pounds of technical material of just 15 major chemical pesticides were produced in the United States in 1958. In addition, some 2,801,572 pounds of synthetic pesticides, 2,545,565 pounds of organic phosphorus insecticides, along with 4,706,246 pounds of pyrethrum flowers, 355,732 pounds of extract pyrethrum, 1,816,300 pounds of ryonia and $729,189 worth of rotenone root were imported in 1958 for pesticide use. In addition, some 93,160,000 pounds of zinc were used in the production of fungicides. Another 28,346,000 pounds of pentachlorophenol were also used last year as a wood preservative. More than 150 million pounds of herbicides and many other millions of pounds of rodenticides and other control materials are manufactured and used annually throughout America.

Most chemical solvents for pesticide formulations are poisonous and, therefore, they, too, should be considered in the total picture of poisons used. In 1958, some 25 to 30 million gallons or more than 200,000,000 pounds of these chemicals were used in pesticide formulations.

The Honorable Lee Metcalf, as reported in the *Congressional Record* for September 2, 1959, stated that, "at least three billion pounds of these chemicals were sprayed over more than 70 million acres of our crops and timberland to kill insects, weeds and plant diseases last year". In total, it is clear that well over 100,000,000 acres in the United States are sprayed, dusted, or otherwise treated with highly poisonous pesticides annually and at a consumer cost of well over $2 billion per year (*8, 28*). Currently, nearly ⅙ of our croplands and millions of acres of forest and rangelands are treated from one to seven or eight times each year with the same or different pesticides in quantities of a few ounces to more than 20 pounds at each application.

One State plant board inspector from Mississippi has reported (*26*) that the major cotton producing section of his State during the past 10 years has had from 70 to 100 pounds of technical grade insecticide applied to it per acre. In the cotton belt, it is apparent that the amount of technical grade[1] insecticide applied annually to cotton averages from 3 to 7 pounds per acre. In terms of formulated insecticide, the average is from 21 to 77 pounds per acre exclusive of that applied as liquid (*25*). Occasionally, excessive quantities are used. In the Tennessee Valley one farmer reported that he had made 16 applications at 35 to 40 pounds of formulation insecticide per acre, or a total of 560 to 640 pounds per acre per season (*40*). Several were reported to have applied 200 pounds per acre per season. It is essential to remember that pesticides usually are applied year after year to essentially the same farm land. It seems logical to assume, as Rudd and Genelly (*27*) have pointed out, that the potential hazard to wildlife, as well as to people, increases with the pesticide volume applied and the toxicity of the poisons used.

### Do These Chemicals Become Pollutants?

There is abundant proof that there often are immediate ill effects upon wildlife resulting from many of the eradication and control programs and that the soil is polluted with some of these toxicants for many years (*3, 8, 12, 17*). There also is considerable evidence of serious side effects (*7, 9, 39*) that are generally overlooked because of the delayed action when highly toxic, stable and broad spectrum poisons are used in quantity. It should be obvious that the only reason for using any pesticide is that it is toxic to something. Some of these poisons are not very toxic to man while others are among the most toxic materials known. There is much evidence that some of these chemical poisons are getting into our water systems. In some areas, where the chemical concentration of poisonous pollutants has been high, there has been considerable loss of wildlife resources. The more subtle, indirect, and long range effects of these toxicants upon man and his wildlife resources are not known. They could be profoundly important. The effects, if any, of the ingestion of small doses of these chemical pollutants are not understood. It is well known that trace elements in infinitesimal amounts can and often do exercise extraordinary influence on life, which seem out of all proportion to their size. Minute quantities of drugs in the system may ultimately have favorable or unfavorable results. It has been repeatedly asserted by our authorities that "No one at this time can tell how much or how little of a carcinogen would be required to produce cancer in any human being, or how long it would take the cancer to develop." Likewise, it is well to realize that an incredibly small amount of virus, bacteria, mold, or sperm cells placed in a favorable environment can initiate profound changes in the organisms they enter. It may be dangerous to ignore the effects of small quantities of pesticides in our water system. Dr. Woodward (*38*) of the U.S. Public Health Service has warned that, "In general these chemicals are undesirable additions to water and every effort should be made to keep their concentration not only below the threshold of any toxic effects but also as low as is reasonably possible".

---

[1] Technical grade pesticide refers to the toxic chemical and it usually represents 10 to 15 percent of the total bulk after the dust or liquid carrier is added.

## Pesticides and Water Problems

Pesticide compounds may enter our water supply through direct application to the water surface, by drifting on to the water surface from adjoining treated areas, or by being washed in from the watershed. Detergents, and domestic and industrial pollutants have entered water courses and ground water aquifers by being washed into our streams from seepage, cesspools, absorption fields, oxidation ponds used in treating municipal sewage, ponds holding industrial or commercial wastes, or by natural and induced infiltration from streams or channels receiving sewage and other waste products.

When large amounts of stable chemical poisons are broadcast over extensive acreages, it is virtually certain that some will get into our public water supplies. It is well known that they are not readily detected in water (*31*). Detergents, known commonly as ABS (alkyl benzene sulfonate), have been found in streams at concentrations sufficient to kill fish. Further, they have been found in ground water in concentrations even exceeding those found in surface waters. Studies are needed to determine the presence of pesticides in ground and surface water, especially in areas of heavy use. More practical, economical, and effective means of removing them are needed *(38)*.

Pesticides already have been found in the major rivers of the Nation. DDT has been found in concentrations in the range of 1 to 20 p.p.b. in the Mississippi at Quincy, Illinois, and at New Orleans, in the Missouri at Kansas City, in the Columbia River at Bonneville Dam, Lake St. Clair, and the Detroit River. Aldrin was found in the Snake River at Pullman, Washington, at 1 p.p.b. Other, and even more toxic, pollutants have been found in many smaller streams in nearly all parts of the country, which have resulted in extensive fish kills. Fish and their food organisms have been killed over considerable stretches of streams, and fish flesh has been tainted and made unuseable by different pesticides.

### Fish Kills

As a means of detecting pollution problems in streams throughout the country, the U.S. Public Health Service, under the leadership of James Harlan, and with the cooperation of State conservation departments, State health departments and water pollution control agencies, initiated a national survey of fish kills. In the returns from 28 States, covering the four months from June through September, more than 200 reports of individual kills were recorded. The number of fish lost varied tremendously in the different instances of poisoning from "a few" to "five million". In the majority of the cases the extent of loss was not recorded specifically.

The three highest cases of losses were caused by industrial poisoning, although "agricultural" poisons (pesticides) accounted for 38 percent of the cases. Many of these were serious and represented complete kills. This was followed by industrial pollution with 27.7 percent, domestic sewage with 7.7 percent, mining wastes with 3 percent, miscellaneous or other causes 9.7 percent, and unknown or undetermined pollution with 13.9 percent of the cases. Because of the difficulty in identifying kills by pesticide poisoning and the relative ease of tracing losses caused by industrial and mine wastes and domestic sewage, it seems possible that a goodly portion of the unknown causes may have resulted from the use of pesticides.

The severity or extent of die off was high in most cases of industrial and pesticide losses. In the agricultural or pesticide kills, 8 percent of the cases were not appraised as to severity. The kills of fish in local areas up to 19 miles of stream were listed as complete in 34.7 percent of the cases. Heavy loss was recorded in 33.3 percent, moderate kills in 13.3 percent and light kills in the remaining 10.7 percent of the cases.

## Pesticide Toxicity

While many chlorinated hydrocarbon pesticides were listed as being the cause of the fish kills, Endrin seemed to have been the one most commonly listed. This is not surprising in view of the fact it is the most lethal pesticide to fish yet developed. Because of its high toxicity, it also is commonly used as a rodenticide and surprisingly too as an insecticide on vegetables! Like most chlorinated hydrocarbons, it is a broad spectrum, stable, highly toxic poison. The infinitesimal amount of 0.6 p.p.b. will kill 50 percent of test bluegills in a period of 96 hours. This high toxicity may be visualized more clearly by stating that the same concentration would require only 0.005 of a pound of Endrin in three acres of water one foot deep (or one acre, three feet deep) to kill 50 percent of the bluegills in a 96-hour period. By continuous exposure for 20 days, much less than this amount would be lethal. Tarzwell (*29*), Henderson et al (*16*), and DeWitt (*7*) have shown the high toxicity of the newer pesticides. Toxicity of the ten most commonly used chlorinated hydrocarbons to fish tested to date, in descending order of potency, is as follows: Endrin, Toxaphene, Dieldrin, Aldrin, DDT, Heptachlor, Chlordane, Methoxychlor, Lindane, and B.H.C. There is some variation in the order of the effects these chemicals have upon birds and rodents, but B.H.C. and Methoxychlor are generally the least toxic to terrestrial warm-blooded vertebrates. Shrimp and other related invertebrates are highly susceptible to pesticides (*2*).

Of the organic phosphorus compounds, Guthion is by far the most toxic to fish and it ranks close in toxicity to toxaphene. This group of poisons varies greatly in toxicity with the various species of fish. Malathion is about 250 times more toxic to bluegills and about 500 times more toxic to chinook salmon than to fathead minnows (*31*). Some of this group of toxicants hydrolize quickly and generally are not as highly toxic after 24 to 96 hours as are the chlorinated hydrocarbons. Furthermore, they do not have the long term residual effects as do the chlorinated hydrocarbons.

That the runoff from treated areas can be toxic to fish has been demonstrated many times. Tarzwell (*31*) obtained runoff from a small area treated with Dieldrin at the rate of 4.6 pounds per acre as a part of a white-fringed beetle eradication program and found that it was toxic to fish in a dilution of 1 to 3 (*30*). A sample of a domestic water from an orchard area in Pennsylvania was found to be lethal to fish in four hours. One pound of Dieldrin per acre on a 20,000 acre tract in St. Lucia County, Florida, used to control sand flies, killed some 20 to 30 tons of fish. Burdick, Dean and Harris (*1*), in New York State, used Sevin at 1¼ pounds per acre as an insecticide in an aquatic environment. It was found to be devastating to all insect life, but it produced no noticeable direct ill effects upon fish or wildlife.

Young and Nicholson (*40*) found that there was a serious valley-wide (TVA) fish kill in 15 streams in eight counties of northern Alabama in 1950, caused by heavy use of Toxaphene, DDT, B.H.C., and Aldrin to control the cotton boll weevil. Some 26-million pounds of these pesticides were used during that summer. Heavy rains washed the toxicants into the streams and excessive fish loss resulted in all streams studied.

### Forest Sprays and Fish

Spraying an extensive forest area against spruce budworm (*19, 20, 21, 22, 23, 36, 37*) in the watershed of the Miramichi River in New Brunswick in 1956, at the rate of one-half pound of DDT per acre, produced a 91 percent kill of young salmon. Aquatic insects also were largely wiped out and some of these were not re-established sixteen months later. As expected, an alarmingly reduced adult Atlantic salmon run was noted in 1960 when the 1956 hatch returned to spawn in the Miramichi River system.

In June 1958, some 302,000 acres of northern Maine forest (*35*) were sprayed with DDT at the rate of 1 pound per acre to control spruce budworms. Studies were conducted on the effects of this toxicant on fish. Loss of trout was moderately heavy. Young of the year comprised 30 percent of the loss. Suckers, minnows, sculpins, and sticklebacks were most readily affected. Populations of young-of-the-year trout were very low a month and three months after spraying. A strong 1959 class run helped materially to restore populations. Trout collected 3 months after spraying contained from 2.9 to 198 p.p.m. DDT. A significant growth decrease was noted in trout in sprayed areas a year following spraying. The population of brook trout was reduced considerably. The most serious effect was on the young of the year.

During mid-June 1957, some 155,000 acres of forest in Vancouver Island, British Columbia were sprayed (*6*) with 1 pound of DDT in 1 gallon of solvent per acre to control the blackheaded budworm. Fish mortality was serious to coho fry, trout, steelhead yearlings, and possibly alevins of both trout and steelhead. In the four major streams affected by spraying the progeny of the 1956 escapement of about 43,000 coho adults and the juvenile stages of several thousand steelhead and trout were almost eliminated. The aquatic insect loss was extreme. Based on this study, it is evident that the safe concentration of this formulation is below 0.05 p.p.m.

Spraying an extensive forest area in Montana in the summer of 1956 with 1 pound of DDT per acre against the spruce budworm showed variable results (*14*). The watersheds of seven mountain streams were treated. By the end of the summer populations expressed in volume of fish and insect foods exceeded those preceding the spraying in one of the streams. On five streams, quantitative recovery had progressed considerably but did not equal prespray populations. On the seventh stream, recovery was practically absent. Game fish reductions of 70 to 80 percent on two of the seven streams were noted.

In the early winter, 4 months after the area had been sprayed, fish in large numbers were found dying in Yellowstone River 90 miles downstream below the area treated. On this watershed 300,000 acres had been treated in 1955, and another 800,000 acres in 1957. Some 600 dead and dying whitefish, brown trout, and suckers were noted in 300 yards of stream. DDT was found in these fish. Bottom organisms in one tributary had reached prespray quantities by the end of the second summer after spraying, but were still below this in five other streams. Still another stream showed only slight recovery by that time. Some early 1957 spraying showed no appreciable loss, except with suckers, until November and December. It is interesting that this delayed mortality was most severe with the fall spawners—brown and brook trout and whitefish. The sucker mortality occurred just after spawning. It is apparent that the major loss occurred when the fish were in poor condition and under physiological stress.

### The Clear Lake Problem

That various organisms can store chlorinated hydrocarbons has been demonstrated at Clear Lake, northern California, where DDD was used to control pest midges (*13, 18, 31*). Large scale treatment started in the summer of 1949 and was repeated in 1954. In December 1954, about 100 western grebes were found dead and still more succumbed in March of 1955. In 1957, another DDD treatment was made to control the gnats. More grebes died in 1957. Chemical analysis revealed these contained 1,600 p.p.m. of DDD. Various fish were collected and chemically analyzed and their stored fat showed DDD ranging from 40 to 2,500 p.p.m.

In 1958, a further loss of birds occurred. In the summer of 1960, a composite fat sample of 12 California gulls and five western grebes contained 2,134 and 1,465 p.p.m. respectively of DDD. These samples were collected 23 months after the last pesticide treatment of Clear Lake, again indicating the high levels of accumulation and the long residual life of this poison in birds. These birds were shot and appeared normal. An interesting, and I believe profoundly important sidelight, is that although there were at least 30 pairs of summer breeding western grebes at Clear Lake in 1960, no young were produced and none are known to have been produced there since 1957. It is to be remembered that this lake, since the beginning of its recorded history, has been a favored nesting and production area for western grebes.

Another note of interest is that plankton collected showed DDD at the rate of 5.3 p.p.m. This is perhaps the more interesting in view of the fact there had been several plankton blooms in the 23 months since the last application of pesticide. No trace of DDD has been found in water samples analyzed except those taken shortly after the pesticide application.

That the pesticide poison tended to accumulate and concentrate over a considerable period of time, was shown by the fact that almost invariably the older fish contained more DDD than did the younger individuals. Four to five times as much DDD was found in 7-year bass as in yearlings. It is apparent that the fish had concentrated this poison in their bodies many times higher than in the surrounding water. All fish, bird, and frog samples analyzed from all sections of this 19-mile long lake contained DDD and all flesh examined showed concentrations far exceeding the active insecticide rates in the water. There was a noticeable differential in tolerance and susceptibility to DDD by different species of fish. Carnivorous fish accumulated more DDD in their bodies than did the plankton-eating fish.

The Clear Lake pollution and the more complex and difficult situation at the Tule and Klamath Lake sumps show that the indirect and delayed nature of the effects of pesticide pollution often are far more serious than are the immediate effects. Birds and fish of many species in Tule and Klamath Lakes apparently have been poisoned by accumulations of several chlorinated hydrocarbons, including Toxaphene, DDT, DDD and its analogue DDE. Some of these pesticides have not been used in or adjacent to these lakes.

Hanson (*15*) concluded from a study of waterfowl nesting in marshes of North Dakota that Toxaphene and oil proved harmful to animal life in the marsh. Only six young birds were known to have been reared from 21 nests or broods in an area treated with this poison. Likewise, he found that Chlordane also interfered with reproduction as only 34 birds were produced from 25 nests in an area treated with this toxicant.

## Ground Water Contamination

With the amount of chemicals being used, including pesticides and detergents, it seems inevitable that some of these materials ultimately would enter our watercourses and even penetrate into the underground aquifers. A number of startling examples already are on record.

*Montebello, Calif.* (*10, 33*): In June 1945, a small plant in Alhambra, California began manufacturing 2,4–D. A batch of the raw material failed to react properly and the chemicals were dumped inadvertently into a sewer. Thence, this waste entered the Alhambra pumping station, passed through the Tri-Cities activated sludge sewage treatment plant, and was discharged into a mile-long ditch. From here the contaminant traveled some 3 to 5 miles above ground, then seeped into the underground strata from which Montebello, a city of about 25,000 population, obtained its water supply. Within 17 days after the manufacture of the weed killer started, taste and odor of a chemical used in the manufacture, 2,4-D dichlorophenol, was noticed in the eleven wells supplying the City. The operation of the plant was stopped within 30 days, yet the taste and odor of dichlorophenol persisted for 4 to 5 years. This case is interesting and important because it shows the possible long-time effects from wastes even though they were unwisely discharged over a relatively short period.

*South Platte River Basin Near Henderson, Colo. (32)*: This represents another significant and historic case in the serious pollution of underground water. As a war measure in 1943, the Rocky Mt. Arsenal of the Chemical Corps, located immediately north of Stapleton Municipal Airport, Denver, started to manufacture warfare agents. In 1955, the arsenal was leased to the Shell Oil Company which has used the plant to manufacture insecticides. Five different oil refineries and two manufacturing concerns have operated in close proximity.

It seems probable that sludge from the pond used at the arsenal by the Chemical Corps between 1943 and 1955, to hold chemical waste effluents, is the source of the contamination. Phytotoxic substances in this waste included chlorates and phosphonates. It appears that other waste substances in the discharge in the presence of air, water and sunlight caused these waste materials to combine and form 2,4-D. There is no evidence to indicate that the herbicide 2,4-D had been purposefully manufactured at the arsenal. We must assume, therefore, that the 2,4-D was synthesized in the waste mixture from precursors introduced from the plant operation. There may also be other contaminants.

The first farm crops to be affected were in 1951. It apparently took 7 to 8 years for the contaminated water to travel approximately 3 miles. By 1958, contaminated water extended in an area of several square miles and seriously affected crop production, industry, and the people who had relied on the water for their own culinary purposes and for livestock. At least one case of illness has been shown to have been caused by drinking this polluted water. The area within this acquifer basin, much of which is not yet affected, is said to cover some 60 square miles. How long this pollution of poisons will last and what total damage yet will result is unknown, but obviously it will be many years before the damage is corrected. Many shallow and some deep wells occur within this basin, and approximately 150 residences are within the known or suspected area of contaminated shallow ground water. No information now is available on the course and rate of flow of the contaminated water arriving in the vicinity of South Platte River.

## Wells

The common frothing household detergents, consisting of alkyl benzene sulfonate and referred to as ABS, give convincing evidence that pollution in shallow ground water is common. Because ABS is not found in any natural substance, its presence in water is evidence of contamination. Frothing is said to occur in concentrations as low as 0.6 mg/1. Pollution containing ABS in ground water may come from seepage from cesspools and absorption fields, oxidation ponds, natural and induced infiltration from streams or channels receiving sewage, holding ponds for industrial and commerical wastes, and facilities for waste disposal from commercial laundries.

Housing developments, wherein each dwelling is serviced by its individual well and sewage disposal system, often invite pollution. Walton (*34*) points out that 35 percent of 600 well waters analyzed from Suffolk County, Long Island, New York, contained ABS, and it is estimated that there are, or soon will be, some 17,000 ABS-contaminated wells in that county! A survey of 54,000 private well waters in the vicinity of Minneapolis and St. Paul showed about 50 percent pollution. Studies from 976 well waters in 13 States showed that 36.6 percent of these contained ABS.

As evidence of the persistence of this detergent, at Kearny, Nebr., ABS was known to travel underground some 4,000 feet in 14 months, where it was found to contaminate a private well. The concentration of detergents found in many wells has been much higher than was normally found in surface waters (*38*). There is reason to believe that similar pollution situations are developing in localized areas where stable and highly toxic pesticides have had heavy and extended use and where the soil is comparatively porous and the ground water table is shallow.

## Conclusion

The enormous and ever growing quantity and kinds of extremely toxic, broad spectrum, stable chemicals used as pesticides throughout America give warning that an objective forward look is necessary. If our people are to receive protection as well as benefit from the mature and safe use of these needed pesticides, there must be more advanced planning and better coordination in the management and use of chemical controls. I believe that dangerous and costly pollution of both surface and ground water with these poisons is inevitable unless effective steps are promptly taken. Recent case histories of pollution confirm this view and show that such contamination may be serious and its correction slow and costly. Because of the nature of the problem, more effective controls must be placed on the distribution and use of dangerous toxicants at the source. This, I believe, should include more effective testing, registration, labeling, and distribution of poisons. I am convinced that we need a clearer declaration of national policy by Congress and by many States regulating the use of pesticides in the broad public interest. More effective coordination must be obtained between agencies and interests directing control and those groups and agencies of State and Federal Government, as well as national and local interests, that are vitally affected by operational programs.

There is critical need for more adequate support of basic research *(5, 24)*. Many costly mistakes and controversies of the past have been kindled through a painful lack of facts on which to act. Sound research should precede an operational program of control and eradication.

It is apparent that the establishment of safe limits of toxicants in water is an involved and long-term undertaking. Yet safe and clearly defined standards for water quality are needed. It is essential that public and private forces unite to support a coordinated program of research.

A few additional "*needs*" are submitted for consideration—

1. To the extent possible, use toxicants that are selective that will give reasonable control of a particular pest and do the least damage to desirable forms ot life.

2. Give more emphasis to biological and cultural controls.

3. When chemical controls are necessary, use formulations, methods of application (i.e., mode of treatment and carrier), time of treatment, and dosage that will be the least damaging to the biota.

4. Use toxicants that hydrolize promptly and those that can be utilized or broken down by organisms in the soil.

5. Use spot and not broadcast treatment wherever possible.

6. Determine toxicity of runoff and seepage water for different materials, dosages, and modes of pesticide application.

7. Determine the toxicity of the toxicant to the various organisms in the environment.

8. Direct research toward side or indirect effects of various pesticides.

9. Develop more specific controls.

10. Study the total environment and its management so that control can be carried on more wisely.

## References

1. BURDICK, G. E. and H. F. DEAN and E. F. HARRIS. 1960. Effect of sevin upon the aquatic environment. N.Y. Fish & Game Journal. 7(1): 14–25.
2. CHIN, EDWARD. 1960. Insecticide studies. Fishery Research, Circular No. 92, Galveston Biol. Lab., U.S. Fish & Wildl. Serv., Galveston, Tex.

3. Committee Report. 1959. Pesticides and wildlife. Proc., Int. Assn. Game, Fish & Cons. Comm., 49: 82–96. Hopkins, Minn.

4. Cope, Oliver B. and Paul F. Springer. 1958. Mass control of insects: the effects on fish and wildlife. Bull. of the Ent. Soc. of Am. 4(2): 52–56.

5. Cottam, Clarence and C. M. Tarzwell. 1959. Research for the establishment of water quality criteria for aquatic life. Trans., Seminar on Water Poll., Tech. Report W–60–3, USPHS, Taft Sanitary Eng. Center Cincinnati, Ohio.

6. Crouter, R. A. and E. H. Vernon. 1959. Effects of Black-headed budworm control on salmon and trout in British Columbia. The Canadian Fish Culturist. Issue 24, Feb.

7. DeWitt, J. B. 1956. Chronic toxicity to quail and pheasants of some chlorinated insecticides. Jour. of Agr. & Food Chem. 4(10): 863–866.

8. DeWitt, James B. and John L. George. 1960. Pesticide review, 1959. Circular No. 84, U.S. Bur. Sport Fisheries & Wildl. 36 pp. Processed. Wash. D.C.

9. DeWitt, J. B., C. M. Menzie, V. A. Adomoites and Wm. L. Reichel. 1960. Pesticide residue in animal tissue. Processed. Bur. Sport Fisheries & Wildl. Wash., D.C.

10. Doll, Byron E. 1947. Formulating legislation to protect ground water from pollution. Jour. AWWA 39(1003): 1006.

11. Ettinger, M. B. 1960. A proposed toxicity screening procedure for use in the water works. Processed, Taft Eng. Center. U.S. Publ. Health Serv. Cincinnati, Ohio.

12. George, John L. 1959. Effects on fish and wildlife of chemical treatment of large areas. Jour. of Forestry 57(4): 250–254.

13. Glading, Ben. 1960. Personal communication.

14. Graham, Richard J. 1960. Effects of forest insect spraying on trout and aquatic insects in some Montana streams. Trans. of the 1959 Seminar, Tech. Report W60–3, U.S.P.H.S. pp. 62–65. Taft Sanitary Eng. Center, Cincinnati, Ohio.

15. Hanson, Wm. R. 1952. Effects of some herbicides and insecticides on biota of North Dakota marshes. Jour. Wildl. Mgt. 16(3): 299–308.

16. Henderson, C., Q. H. Peckering and C. M. Tarzwell. 1959. Relative toxicity of ten chlorinated hydrocarbon insecticides to four species of fish. Trans. Am. Fishery Soc. 88: 23–32.

17. Hickey, Jos. J. and L. B. Hunt. 1960. Initial songbird mortality following a dutch elm disease control program. Jour. Wildl. Mgt. 24(3): 259–265.

18. Hunt, E. G. and A. I. Bischoff. 1960. Inimical effects on wildlife of periodic DDD applications to Clear Lake. Calif. Fish & Game 46(1): 91–106.

19. Ide, E. P. 1956. Effect of forest spraying with DDT on aquatic insects of salmon streams. Trans. Am. Fisheries Soc. 86: 208–219.

20. Keenleyside, Miles H. A. 1959. Effects of spruce budworm control on salmon and other fishes in New Brunswick. The Canadian Fish Culturist. Issue 24, Feb.

21. Kerswill, C. J. 1958. Effects of DDT spraying in New Brunswick on future runs of adult salmon. The Atlantic Advocate 48(8): 65–68.

22. Kerswill, C. J. and P. F. Elson. 1955. Preliminary observations on effects of 1954 DDT spraying on Miramichi salmon stocks. Progress Report of the Atlantic Coast Station of the Fisheries Research Board of Canada. Issue No. 62, pp. 17–24, July.

23. Kerswill, C. J., P. F. Elson, M. H. A. Keenleyside and J. B. Sprague. 1960. Effects on young salmon of forest spraying with DDT. Trans. 1959 Seminar, page 71, U.S.P.H.S. No. W60-3. Taft Sanitary Eng. Center, Cincinnati, Ohio.

24. Middleton, F. M. and James L. Lichtenberg. 1960. Measurements of organic contaminants in the nation's rivers. Industrial & Eng. Chem. 52: 99A-102A.

25. Nicholson, H. Page. 1959. Insecticides—agricultural usage in the Southeastern States. Processed and personal communication.

26. ———. 1959. Insecticide pollution of water resources. Jour. Am. Water Works Assn. 51(8): 981-986.

27. Rudd, R. L. and R. E. Genelly. 1956. Pesticides: their use and toxicity in relation to wildlife. Calif. Div. of Fish & Game, Game Bulletin 7, 209 pp.

28. Shepard, Harold H., John N. Mahan and Charlotte A. Graham. 1959. The pesticide situation for 1958-59. U.S.D.A. Commodity Stabilization Serv., Washington, D.C.

29. Tarzwell, Clarence M. 1958. The toxicity of some organic insecticides to fishes. Proceedings of the Twelfth Conference of the Southeastern Assn. of Game & Fish Comm., Columbia, S.C. Contrib. No. 116, pp. 223-239.

30. Tarzwell, C. M. 1960. Pollution effects of organic insecticides. Trans., 24 the No. Am. Wildlife Conference, pp. 132-142. Washington, D.C.

31. Tarzwell, C. M. and B. B. Berger. 1960. Pesticides in our public waters. (Manuscript yet unpublished.)

32. Walton, Graham. 1959. Public health aspects of the contamination of ground water in South Platte River Basin in vicinity of Henderson, Colorado. August. Processed. 27 pp. U.S.P.H.S. Taft Sanitary Eng. Center, Cincinnati, Ohio.

33. Walton, Graham. 1960. Unpublished notes, personal communication.

34. ———. 1960. Chemical indicators of sewage contamination of ground water. Processed. 24 pp. U.S.P.H.S., Taft Sanitary Eng. Center, Cincinnati, Ohio.

35. Warner, Kendall and Owen C. Fenderson. 1960. Effects of forest insect spraying on Northern Maine Trout Streams. Processed, 29 pp. Maine Dept. of Inland Fisheries & Game. Augusta, Maine.

36. Webb, F. E. 1959. Aerial chemical control of forest insects with reference to the Canadian situation. The Canadian Fish Culturist No. 24, February, 14 pp.

37. ———. 1960. Aerial forest spraying in Canada in relation to effects on aquatic life. Trans. of the 1959 Seminar in water pollution, pp. 66-70. Tech. Report W60-3, U.S.P.H.S. Taft Sanitary Eng. Center, Cincinnati, Ohio.

38. Woodward, Richard L. 1960. Pesticides and water supplies. Processed address. U.S. Publ. Health Serv., Taft Sanitary Eng. Center, Cincinnati, Ohio.

39. Wright, Bruce S. 1960. Woodcock reproduction in DDT sprayed areas of New Brunswick. Jour. Wildl. Mgt. 24(4): 419-420.

40. Young, L. A. and H. P. Nicholson. 1951. Stream pollution resulting from the use of organic insecticides. The Progressive Fish Culturist 13(4): 193-198.

**Dr. ACKERMAN.** Thank you, Dr. Cottam, for a most interesting array of facts, and for your conclusions.

I would just like to add one word of my own to that, and that is we should not only be concerned about the effects of these new chemicals that have been so useful to us economically and will continue to be so—we should not only be concerned about them for their effect on fish and wildlife and their continued existence in the streams and land associated with streams—but I think we should commence to be just a little more concerned, possibly a bit worried, about what this means for other forms of life, including ourselves.

There are beginning now some interesting studies among those who are interested in pure research, in biochemistry, in what they call comparative biochemistry. And they are finding that there are some surprising similarities in the biochemical processes among all forms of life, at least those that have been studied thus far. This to me would indicate that there are reasons, at least biochemically, why we should think about the things that Dr. Cottam has discussed.

## DISCUSSION

Dr. L. A. Dean
***Research Investigations Leader***
***Soil and Water Conservation Research Division***
***Department of Agriculture, Washington, D.C.***

At the outset, I wish to emphasize the importance of the role of chemicals in our modern agriculture. Perhaps, it is hard for one not closely associated with agriculture today to realize how utterly dependent we are on chemicals. These chemicals are essential for the efficient production and quality of the very foods we consume. Our consumers today demand a high quality of wholesome farm products.

In fact, you and I have only two choices. To accept the use of chemicals or eat wormy apples.

The purpose of chemicals in agriculture can be divided into three classes:

(1) Chemicals are used to control insects, diseases, weeds, and other pests. (2) Chemicals are applied to soils, to plants, and added to livestock feed to control growth. (3) Chemicals are used in the processing and marketing of agriculture produce to retard spoilage and maintain food of fresh quality and attractiveness.

The public, in accepting the use of chemicals in agriculture on one hand, does not, on the other hand tolerate food which is not safe and has every right to demand assurances that their food is free from the harmful effects of any chemical which is used in agriculture. This restriction applies equally well to water supplies. As of today, our record of safety is excellent.

Dr. Cottam's paper has emphasized insecticides. The size of the total production of these chemicals has been cited as a criterion of probable water pollution hazard. These same statistics also serve to emphasize the importance of insecticides. Insects are man's greatest competitor for the food he eats. Our very survival involves the successful control of insects. Nevertheless, there is no reason to minimize the potential hazard of any chemical. There is always a calculated risk that must be evaluated. Agriculture has a definite responsibility in the safe use of chemicals.

In order to orient our perspective regarding the risk of chemicals in agriculture, let us consider an acre of farm land in the lower Mississippi Valley where the use of insecticides is important. The first acre-foot of this soil will weigh 4 million pounds and when moist it will also contain 30,000 gallons of water. This mass is available for dilution and entrapment of the insecticides, the average dilution ratio being in excess of a millionfold. Chemical, physical, and biological reactions in the soil oxidize, fix or, otherwise destroy most insecticides. The time required varies from a few hours to days. The soil is not an inactive mass. In fact, only a few organic chemicals are stable in this environment.

Most insecticides are highly insoluble in water, and the amounts that will become associated with the rainfall are exceedingly small. The second requirement for pollution to be affected by this vector is that the rainfall on crop lands recharges surface or ground water. Average estimates of the water runoff from the surface of cropland in the lower Mississippi Valley approximate 100,000 gallons per acre per year. Good soil and water conservation practices will reduce this figure even lower. During the summer and fall the amounts of water percolating through the soils is negligible. During these months all of the rainfall which is absorbed by the soil returns to the atmosphere by the process of evapo-transpiration. The average rate of loss is 6,000 gallons per acre per day or 0.2 of an inch. Thus, ample time is provided for the inactivation of insecticides by the soil. Leaching experiments have shown that a wide variety of modern organic insecticides do not leach through soils. There does not seem to be any analogy between the pollution of shallow well water with water soluble detergents from household or other use and the case where insecticides are applied to crops and soils.

Regrettably, there have been isolated instances where chemicals used in the control of insects have temporarily contaminated the habitats resulting in the destruction of limited quantities of wildlife such as fish. The significance of such instances has been a matter of controversy in the past. However, a review of the information at hand strongly indicates that there has been no lasting damage.

In this regard, a specific example might be cited. In 1957, 14 plaintiffs from Long Island sought to restrain the Secretary of the U.S. Department of Agriculture and the State Commissioner of Agriculture and Markets from committing trespasses upon their lands by means of low-flying planes and spraying their lands to eradicate the gypsy moth with DDT. At this trial about 50 witnesses testified over a period of almost a month. In the over-all, the decision was in the favor of the defendants. Judge Bruchhausen stated the following: "The plaintiffs have not sustained their claim that spraying causes any considerable loss of birds, fish, bees, and insects. Only a few fish and birds were killed in the subject area. Furthermore, evidence of spraying programs throughout the country demonstrates that the fish, bird, and bee loss has been inconsequential. While there is no evidence of damage to bees and aquatic insects in the subject area, experts and others from various sections of the country established that the defections are made up by repopulation in a short space of time."

The continued efficient and safe use of chemicals in agriculture is in the national interest. Important future developments through research are proposed. New research can help in two ways. First, we can develop new chemicals and methods of use which will be beyond suspicion on the grounds of safety. Second, we can develop nonchemical methods for doing the same job that we are now doing with chemicals. This necessary progress through research has been recognized by the U.S. Department of Agriculture. In April 1960, a symposium on The Nature and Fate of Chemicals Applied to Soils, Plants and Animals was held by the Agricultural Research Services. At this 3-day meeting, symposium speakers discussed new development in research dealing with agricultural chemicals and the responsibilities of Federal agencies and industry in assuring the safety of chemicals used in agriculture. A report of this symposium was published in September 1960.[1] This report emphasized the role of research.

## PANEL II

### General Discussion

**Mr. LAWRENCE.** I am going to ask Dr. Cottam if he would care to comment on Dr. Dean's paper.

---

[1] "The Nature and Fate of Chemicals Applied to Soils, Plants, and Animals". ARS 20-9, September 1960, Agricultural Research Service, U.S. Department of Agriculture, Washington 25, D.C.

**Dr. COTTAM.** I did not expect this, and therefore I made no notes, but I have a few impressions.

I would say by and large I would agree with his conclusions. There may be a slight difference in degree of our conception of the place and role of pesticides. I think we are both in full agreement on a good many points, and one is the necessity for research. I think we both equally recognize the need for that, and both equally recognize that pesticides are here to stay and that chemicals are here to stay.

That does not mean, however, that we should always retain all of the same chemicals and present formulations now in use. Some, I hope, will be replaced after a period of time. In the last 5 years, there has been a growing trend, and it has been a definite trend, from the more specific to the more broad spectrum type of poison, and, still more, from one of relatively low toxicity to one of greater toxicity. Unfortunately, many of these are very stable and very toxic compounds. That is the type of thing I think is dangerous and undesirable.

When he says, for example, that there are no startling cases that have developed, I would say he may be correct. We have not died yet, but I think the intelligent approach is to take a look at the future.

For example, go to your records and see what the incidence of cancer is today compared to what it was in 1914. The rate of lung cancer, I believe, has increased over 4,000 percent in that period of time, and I doubt that all of this increase is due to the use of tobacco. Some of you birds were smoking tobacco before then. All I want to say is that some of these other things may be factors, and I suggest the safe approach is to take the conservative side when there are two possible approaches to take, because if you die once, that is the end of it as far as I have been able to find out.

And I think we are running an unnecessary risk when we just blithely go ahead and use these things because we have not died yet. It is true that we don't have all the proof of these things yet. There are proofs that are needed without any question. We need to stress the research aspects of this, I think, much more than we have in the past. We have been proceeding with scant knowledge as to the side-effects or the long-term effects.

For example, may I point out just a few things in agriculture (I was born and raised on the farm, yet I am not a professional agriculturist). The chemical that may have been used in infinitesimal amounts may result in very profound effects years and years later. Your carcinogens—some of you may remember that a year ago last Thanksgiving there was a little scare concerning the cranberry episode—but let me give you the story of Aramite as an illustration.

Aramite was an important and very effective pesticide that has been used on vegetables and on various crops, fruit and vegetable crops primarily. As I remember the record when it first came out, about four years ago the Food and Drug Administration did not have very good reason for excluding it, so they permitted it on a three-parts-per-million tolerance level. As I recall, the next year after some testing they reduced the tolerance to two parts per million. After they had done a little more testing the next year they further reduced the tolerance level to one part per million. And last April, or somewhere about the beginning of the year, the Food and Drug Administration insisted on a zero tolerance of Aramite. This was done for the very simple reason that nearly all the test rats and dogs, and possibly maybe monkeys, developed cancer. They found that Aramite was a serious carcinogen. The word "carcinogen" in common Irish means it stimulates the growth of cancer.

I think the facts are crystal clear that there has been a rapid rise of cancer in the United States in the last 15 years. It is not at all impossible that the excessive use of pesticides may be a factor in this increase. Some thoroughly reliable medical research men feel that it is.

Some of you people may have a son or daughter or wife succumb, or you yourself may some day. Because of these risks why shouldn't we take a conservative view of this, rather than jump in head first? All I am urging is caution and sanity and maturity of judgment, recognizing the various possibilities of this thing.

We don't need to get scared about it, but we do need to use maturity of judgment in the use of these things. And that suggests one thing we haven't done too well yet, and that is to precede our big eradication programs with adequate and sound research programs so that we know what we are doing. We haven't done that yet in some cases. I can name you one or two if someone wants to challenge me.

**Mr. LAWRENCE.** This a question directed to Dr. Cottam and the questioner would like to make a statement. It is Dr. Abe Eldib of the Esso Research and Engineering Co. I should like to read the question and then ask Dr. Eldib to step to the microphone and make a statement, and ask Dr. Cottam to comment: ***"Scientists can think of ways to prove pesticides, but in order to do effective research we must first determine the manifestation of pollutants on life and health."***

Will you comment, Dr. Eldib. You have 3 minutes.

**Dr. ELDIB.** I won't take that long.

It seems that in the last hour the main word we heard has been "research." I would like to bring up two points in connection with this matter. First, in connection with Dr. Cottam's suggestion about ways by which we can handle the problem of pesticides. He said that we might be able to alter them while they are being manufactured, so that they would not be harmful.

There is a great deal of effort already being made by the industry in trying to alter the composition of the chemicals so that they would have no possible harmful effects after they are discharged into the water.

A second point, however, which is to my mind equally important, or perhaps more important, is the following: We, as scientists, can think of many ways to remove these pesticides from the water. But each group of pesticides may have to be removed by a specific method. In other words, there may not be a universal method to remove all of them.

There is a limited amount of brains, or quality of brains that can solve these problems. Where should we start? We really don't know. Should we remove the detergents? Should we remove the pesticides? Should we remove the DDT? Should we remove this or that?

Therefore, it seems to me that the first step is to pin down what are the toxic effects of these pollutants one at a time, or perhaps a class at a time. And I think once this is established, the chemists and engineers from their knowledge of different phases of science can pinpoint methods that are suited for the removal of each particular type of impurity. If research is going to be done, I think the health manifestations of these pollutants should be established as quickly as possible.

I brought this point up this morning, and they told me that research on pollutants' manifestations on health and life should be done concurrently with research on removal of pollutants. That is, both avenues should be investigated at the same time.

I want the opinion of Dr. Cottam about the following: ***Isn't research on manifestations of pollutants the most important thing to start with, so that we can spend our time and money effectively solving the problem?***

**Dr. COTTAM.** I want to commend the gentleman for his splendid point of view. I heard him in the other room on a similar discussion, and I very much appreciate his general point of view on this thing. I think his stand is well taken that we should pinpoint these things that are in greatest need.

Now, it seems to me there are a number of things that are needed. One is I think that ultimately industry itself that manufactures these chemical pesticides, and particularly these major ones or more toxic and broad spectrum ones with which we are most concerned, such as Endrin, must resolve the problem pertaining to their own toxicants. I feel the company itself should find means of removing that pollutant or preventing it from getting back into our water supplies and especially the underground water. Suppose that instead of a small area of 60 square miles, as I referred to in my paper, you had an aquifer of 600 square miles. If you once pollute that, Lord help you, you're polluted from then on out.

It seems to me we have a number of places to start. These poisons we know are being dumped into streams inadvertently, of course, but

Hell is paved with good intentions. Nobody wants to kill anybody else, but these poisons are going into the streams and into the water supplies and it seems to me these chlorinated hydrocarbons that are relatively stable compounds are dangerous to use indiscriminately. And we ought to have means of removing them.

**Dr. ELDIB.** ***Do we have documentary evidence that these things are really toxic?***

**Dr. COTTAM.** Yes. There is a lot of it. The evidence is as clear as the sunshine. Yes, there's a lot of evidence to that effect.

Now, the interpretation of all that evidence—you'd find some of us differing slightly in the interpretation, but there is evidence. And I think even the extremist on the opposite side from me would admit that there is a lot of evidence.

**Mr. LAWRENCE.** This question is for Dr. Dean and was asked by Mr. Roland C. Clement of the National Audubon Society: ***"In view of the fact that the late Dr. Carr of the University of Chicago said many years ago that it would be better to eat the worm in the apple than the pesticides being put on apples, would you tell us who made the review showing negligible damage to living forms, and when and where this will be published?"***

**Dr. DEAN.** Regarding the view on negligible damage, there are several reviews already published in the literature suggesting this conclusion. I do not have them with me now.

Now regarding the worm in the apple, I think the average apple consumer has made his choice. He does not want worms in his apples.

**Mr. LAWRENCE.** This question is for Dr. Dean and was asked by Mr. Charles P. Beazley of State College of Pennsylvania: ***"Is there any joint committee, including Agriculture, to test pesticides and approve the use of the nontoxic types of fish, oysters, and wildlife? Twenty years ago we had no pesticides and we managed to live. Why so many pesticides now?"***

**Dr. DEAN.** I will only comment on the part dealing with "Why so many pesticides now?" With the present economic and social background farming industry, crop protection through the use of chemicals is essential to our farming industry. This has been one of the means developed to aid the economic survival of the farmer.

**Mr. LAWRENCE.** This question was asked by Mr. Louis S. Clapper of the National Wildlife Federation and is addressed to Dr. Dean: ***"If adequate testing is accomplished prior to field use, why is the U.S. Department of Agriculture lowering its application rate of Heptachlor from the former 2 pounds per acre to ½ pound per acre in the fire-ant program?"***

**Dr. DEAN.** I will acknowledge that I have heard of the fire-ant program and of the fact that it has been subjected to criticism.

Also, it is true that several years ago the rates of application were higher than those current.

**Dr. COTTAM.** I didn't get the full import of that question. Did the gentleman ask: "Is there any joint committee, including Agriculture and wildlife, to study the problem"?

Yes, on paper there is. And I say it is on paper and it doesn't go much further than that. That is mainly the problem that I think is the weak link in this thing.

In this criticism of Agriculture I do not mean to disparage my friends in that great Department; I used to be in Agriculture. For 25 years I was a bureaucrat and know something of their problems. My point is that I do not believe that the control arm of Agriculture should have the right to decree that wildlife is so unimportant that it can be sacrificed or how much can be and when. Agriculture has been doing just that. It has proceeded with little regard to State, Federal, or independent wildlife people. It seems to me the wildlife people should not tell the agriculturist when he is not going to spray, either.

I think there is need of a declaration of national policy on that thing. That question strikes right at the heart of the problem and that has caused the major conflict in the past between agriculture and wildlife interests. Having been in the Fish and Wildlife Service for 25 years, I know something of this problem. Despite comments to the contrary there has been friction between this self-appointed "right" of Agriculture's control division (ARS) and Interior's Bureau of Sport Fisheries and Wildlife.

Do not forget that there is much economic value in wildlife; it is tremendous. I am unalterably opposed to Agriculture's A.R.S. control group or any other group of special interest having the authority to decree when and how much of the wildlife resource shall be sacrificed. Even on particular projects where I agree that control is necessary, I am still opposed to that principle of approach. There is need of a declaration of policy by the Congress.

**Mr. LAWRENCE.** Francis Silver, who is an environmental consultant, would like to read three unpublished case histories regarding health effects on humans, and make a statement.

**Mr. SILVER.** These case histories were sent to me in a letter from Dr. Francis M. Pottenger, Jr., of Monrovia, Calif. I wrote to him of my own experiences with pesticides used inside buildings. It has reached a point where I feel it is almost a form of low-grade chemical warfare against our population.

I quote from Dr. Pottenger's letter:

DEAR MR. SILVER:

I have been very much interested in the problem of insecticides, particularly the use of of chlordane in buildings, and have treated several patients who have had serious complications resulting from such poisoning. In fact, the highest titer that I have found in bodily fat came from a woman exposed to chlordane following termite proofing of her house. She had about 700 p.p.m chlordane following acute exposure. Her chief symptomatology was headache, vertigo, nausea, followed by a pneumonitis and a prolonged period of extreme exhaustion and mild disturbance in equilibrium lasting for a period of 3 to 4 years. She has gradually recovered.

I have not published these reports as I should. Other cases that I have dealt with included a woman who ran an antique shop who continuously sprayed her premises with all of the recommended pesticides including DDT, chlordane, and others. She had a very strange type of asthma but did not respond to any of the normal treatment. Atropine was the mainstay in her treatment. She decided to pass on her good fortune to others and got out of the antique business. Her recovery, likewise, was slow, but not as slow as the previous patient, nor was her titer so high.

A woman working in a florist shop had been exposed to all kinds of cut flowers which, as you all know, are sprayed with many pesticides including the organic phosphates as well. She had not only a peculiar pulmonary problem but was extremely nervous and exhausted. She has not had time to recover. Nearly all of the patients I have treated and proved by fat biopsy have been more nervous and irritable (unreasonable) than the average individual. Most have been diagnosed as malingerers, psychopaths, neurotics, and considered to be mentally ill.

I want to comment that chronic poisoning resembles aging, that it is not easy to distinguish these things. So it must be looked for and will not come up and strike one in the face. It mimics other forms of illness.

**Mr. LAWRENCE.** This question was aked by H. Wayne Pritchard of the Soil Conservation Society of America: ***"What do municipalities need to know about Public Law 566, this being the Small Watershed Law, in their efforts to reduce silt pollution from reaching their water supplies? Is there opportunity for municipalities to make use of this law?"***

**Mr. ZIMMERMAN.** The law to which he refers is the Watershed Protection and Flood Prevention Act of 1954, which provides cost sharing by the Federal Government with local communities and local sponsors in behalf of watershed protection, which includes the conservation of soil and water and flood prevention work on limited size watersheds.

If I understand the question correctly, it bears upon the use to which this type of legislation and cost sharing may be put by municipalities.

I would say that any municipality interested in a watershed within the restrictions imposed by the legislation could take advantage of the program, participate in it, and reap certain benefits, particularly in the area in which we have been talking here.

In other words, to the extent that work on the land or the contributing watershed—to the extent that that land may be tied down, the silt and the damaging type of run-off may be halted. A municipality would certainly benefit, and benefit in a very appreciable way.

Increasingly, municipalities are taking advantage of this legislation, this type of program, which originally seemed to have been a strictly agricultural program. It increasingly becomes a combination farm- and city-type program. I believe the prospects are that as time goes on, cities and municipalities will make as much or more use of the watershed act as agricultural interests.

**Mr. LAWRENCE.** This question is directed to Mr. Zimmerman and was asked by Mr. G. O. Fortney of the West Virginia State Health Department: ***"Does the Soil Conservation Service enter into problems where streams are polluted by dissolved chemicals such as acid mine drainage from natural conditions"?***

**Mr. ZIMMERMAN.** Soil Conservation Service of the Department of Agriculture would normally not get into that kind of an operation. The Service is made up of a corps of conservation technicians encompassing agronomy, engineering, and a few other fields. The services of these technicians would be available to the mine operators and the like, but it would be a specialized operation on their part, rather an extraordinary one, probably.

**Mr. LAWRENCE.** This is a question from William Spalding of the National Steel Corporation addressed to Mr. Powers which Mr. Cunningham may wish to comment on: ***"To obtain the fullest beneficial usage of our streams effective regulatory bodies have adopted the practice that the discharge into a stream shall be governed by the assimilative capacity as measured at the point of use. What is your thinking on this"?***

**Mr. CUNNINGHAM.** I believe the discharge of waste up to the assimilative capacity of a stream is probably the last resort. I firmly believe that the control should be at the point of discharge.

**Mr. LAWRENCE.** This is another question which I will now address to Mr. Cunningham. This is from John Meehan of the Chamber of Commerce of the United States: ***"What are your thoughts on implementing your suggestions about water user organizations in each watershed, and so forth"?***

Part two of this question is: ***"What agency or agencies should take the lead in this effort"?***

This obviously is directed specifically to Mr. Powers' comment, and you may or may not care to answer this one.

**Mr. CUNNINGHAM.** I would assume that the first question refers to the suggestion Mr. Powers made, such as water-use organizations in each watershed, and so forth. Basically, that is one of the best controls we have; water-use organizations on the alert, working with the enforcement organizations, the research organizations, and those who are collecting data to bring about effective treatment which we have been talking about here today.

The second question is: "What agency or agencies should take the lead in this effort"?

In my opinion, the joint effort of Federal, State, and local agencies make a most effective team. We need the continued leadership of the Public Health Service.

**Mr. LAWRENCE.** This question is addressed to Mr. Cunningham, although I think he may have answered it a moment ago. It is from Grant A. Pettit of the Armco Steel Corp.: ***"Since the value of water is governed by its quality at the point of actual use, is there any reason why this principle should not be adopted as the basis for effective pollution control? Is it not a proper function for those affected, together with local or regional authorities, to determine the beneficial uses in the overall public interest"?***

**Mr. CUNNINGHAM.** Yes, I believe that the basic approach is that the control should be at the point of use and discharge.

**Mr. LAWRENCE.** This question is directed to Dr. Cottam and was asked by Ann C. Free, North American Newspaper Alliance: ***"If you have evidence of toxicity of certain hydrocarbons, do we need more research? Should research then be on removal from water of organic chemicals and greater development of biological controls"?***

**Dr. COTTAM.** It seems to me our first approach should be to use controls. All of us are in favor of controls. We should use those controls that would carry out the objective without doing damage to other organisms. Just bear this in mind, that no controls would be used if they were not toxic to something—otherwise, why use them? Therefore, you will have to go on the assumption that these hydrocarbons are toxic to something or they would not be used.

So the first bit of research that is needed, in my opinion, is to learn the degree of their toxicity, not only to that particular organism, and the chemical manufacturer has to be assured of that or he doesn't sell his product.

Then the next step is: What effect does that have on other organisms affected by that application, if I follow your question correctly. I think we need to know that, because for some of these poisons there may be no substitute in some cases, and if there isn't a substitute we had better get along with the absolute necessity of control where we have to have control. So I think we just can't write them off when we find they are poisonous. They are poisonous or they wouldn't be used. It seems to me we must find out how to eliminate that poison—let it do its job and then eliminate it.

# PANEL III

*Tuesday, December 13*

## Keeping Water Clean

*Responsibilities of Government, Industry, and the Public*

Chairman
**DR. ABEL WOLMAN**
*Professor of Sanitary Engineering, Johns Hopkins University, Baltimore, Md.*

Co-Chairman
**MILTON P. ADAMS**
*Executive Secretary, Michigan State Water Resources Commission, Lansing, Mich.*

Public Health Service
Resource Personnel
J. T. BARNHILL
J. J. FLANNERY
D. H. HOWELLS
MURRAY STEIN

### Morning Session

**Dr. Abel Wolman, *Presiding***

The purpose of a national conference on any subject presumably would be to disclose in some detail the nature of the problem, to define responsibility for past failure, to propose future solutions, to allocate fiscal resources, and to orient society toward sound objectives within the framework of law. These five purposes are to be partly crystalized through the efforts of those participating today in Panel III.

They may be approached by massive breast beating and exhortation by various professional cultists, by perfectionists, and by opportunists. They may be exhaustively concealed by the magic of complex technical and scientific phraseology. Or the panel participants may soberly try to answer complex questions at least in simple terminology, so that a President, Congress, and the public may leave the session reasonably aware of problem and potentially at least of proposed answers.

To accomplish this sober purpose, it would appear that speakers would try to steer a middle ground between damning the public, industry, the government, and searching for simple devices to lead us rapidly to the millennium. Panel III is confronted with a series of questions—all making up a basis for the overriding question as to why our society is slow in correcting the disabilities created by its own wastes.

Some of these questions are here posed, solely for the purpose of crystallizing views directed toward strengthening the results and accomplishments of the conference. Too often, professionals do better in diagnosing the ills of society than in offering cures. Perhaps a few questions may focus attention as much upon therapy as upon diagnosis.

Question 1: The central theme of our Panel is "Keeping Water Clean." A thoughtful observer may very well ask, How clean, and for what purpose? Some consideration must be given to the fact that "clean" is a relative and not an absolute term. In our highly urbanized and industrialized country, the purpose for which we manage our wastes should at least be defined.

The natural waters, underground and surface, show little variations in their constituents due to nature alone. The Panel might, if it saw fit, confine itself to man-made contamination.

Question 2: Who is to do what? Any answer to this question at once places us in the exciting arena of public versus private effort, and of local, State, and Federal responsibility. The easy route of relieving the man on the street of any worry by transferring all responsibility to Washington is one being sedulously explored by the advocates of all of the other "unmet needs" of our world.

The transfer of our problem to the ever-growing competitive area of national responsibility may turn out to be a will-of-the-wisp solution. At any rate, the easy road to cure needs realistic assessment.

Question 3: How does one create a militant, public conscience, without which no cure is likely to work. Abraham Lincoln once pertinently said: "public sentiment is everything. With public sentiment nothing can fail; without it, nothing can succeed. Consequently he who molds public sentiment goes deeper than he who enacts statutes or pronounces decisions. He makes statutes and decisions possible or impossible of execution."

We must indeed face the fact that the public often, but not always, is just not interested. Can we determine here today why he is less than inspired?

Question 4: How do we pay for what we think needs to be done? The search for painless methods of extracting money from recalcitrant people for beneficent public purposes is as old as man himself. This has always been the domain of competition between private and public spending and between our needs as we spell them out this week and the other needs as dramatically presented in the conferences fo follow.

The answer to this question then is a challenge to our imagination and ingenuity. It is not probable that it will be well answered if it rests upon the recurring assumption that our people cannot afford the cost. The continuing emphasis on the bankruptcy of local government is not quite consistent with the continuing expenditure by our people of billions of dollars annually on the auto, the cosmetic, and the other excitements of daily living so characteristic of our country. These latter are hardly the marks of a poverty-stricken population.

Will Panel III in fact disclose realistically the data as to the ability to pay of local, regional, and State governments? Or will it again take the escapist view that local sources have been exhausted. After all, it is these same sources and only these that nourish the coffers of the National Government.

In essence, the Panel could suggest ways of strengthening the fiscal capacity of local public bodies. It would be valuable indeed if the Public Health Service experience over the last few years would in itself shed light on the number and size of communities delinquent because of fiscal inadequacy or because of public apathy.

Question 5: Are the inadequacies of law, in themselves, reflections of public opinion, responsible for laggard action? History shows that sometimes leaders have led people into sound civic action without the force of law. Does uniformity of statute assure greater progress, more cooperative effort, and more rapid correction?

# The Needs and Obligations of Federal Agencies

ROBERT A. FORSYTHE
***Assistant Secretary for Legislation***
***Department of Health, Education, and Welfare***

### I. Introduction

My purpose in this paper is to consider our national policy and programs for water pollution control and to analyze future needs from the standpoint of those policies and programs as we seek the common goal of clean water. I shall to some extent, though not entirely, borrow from our present national policy and programs as enunciated in the Federal Water Pollution Control Act. In doing so, I shall touch in some measure on the areas of concern of each of the other speakers on this and the other panels. One cannot formulate and discuss the Federal role in keeping water clean in isolation from the roles of interstate, State, and municipal agencies; private industries and the general public; and without reference to scientific, engineering, sociological, economic, legal, and political considerations.

So that we may establish a basis for our discussion, it is important to set forth the limits of what is encompassed by the term "water pollution."

Water in its natural state is never 100 percent pure. Rain and other forms of precipitation fall on the earth, bearing impurities absorbed from the atmosphere. Water on and under the earth's surface is subject to further adulteration from contact with its environment including contact with the activities of man. Water pollution as considered in this paper refers only to the impurities in water on and under the earth which result from man's activities. Among these are man-caused pollution of the atmosphere, mining and proc-has always been the domain of competition between private and public spending and between our needs as we spell them out this week and the other needs as dramatically presented in the conferences fo follow.

The answer to this question then is a challenge to our imagination and ingenuity. It is not probable that it will be well answered if it rests upon the recurring assumption that our people cannot afford the cost. The continuing emphasis on the bankruptcy of local government is not quite consistent with the continuing expenditure by our people of billions of dollars annually on the auto, the cosmetic, and the other excitements of daily living so characteristic of our country. These latter are hardly the marks of a poverty-stricken population.

Will Panel III in fact disclose realistically the data as to the ability to pay of local, regional, and State governments? Or will it again take the escapist view that local sources have been exhausted. After all, it is these same sources and only these that nourish the coffers of the National Government.

In essence, the Panel could suggest ways of strengthening the fiscal capacity of local public bodies. It would be valuable indeed if the Public Health Service experience over the last few years would in itself shed light on the number and size of communities delinquent because of fiscal inadequacy or because of public apathy.

Question 5: Are the inadequacies of law, in themselves, reflections of public opinion, responsible for laggard action? History shows that sometimes leaders have led people into sound civic action without the force of law. Does uniformity of statute assure greater progress, more cooperative effort, and more rapid correction?

essing of minerals including radioactive ores, disposal of domestic (sanitary sewage) and industrial wastes, livestock watering, agricultural irrigation and drainage, and drainage of surface waters in municipalities. It also includes significant temperature change in water as discharged following use. Water impurities resulting from conditions occurring in nature without human intervention are outside the scope of the term "water pollution" as used in this paper.

## II. Basis for a National Policy on Water Pollution Control

A vital and broad national interest in water pollution control has been recognized and a national policy has been formulated through action by the Congress and the executive branch of the Federal Government.

It may be useful, however, to consider for a few moments the reasons which underlie the national policy and interest.

The most obvious reasons lie in the following facts: (1) the Nation's fresh water supply, determined by precipitation, evaporation and transpiration, runoff, and regulation through impoundments and other practices, is relatively fixed in amount; (2) our water supply is distributed unevenly both geographically and seasonally; (3) the overwhelming proportion of our surface and ground water sources are multistate in character; that is, they are located in more than one State; (4) the overwhelming majority of water use in the United States consists of reusing water which has theretofore been used in another State; (5) water pollution has a number of seriously adverse effects including the following: it decreases the usable supply of water for many purposes to the point of actually making impossible some uses; it increases the cost of using water for many purposes; it creates a bias in favor of present, versus potential future, uses of water; it creates hazards to public health; it tends to lower riparian property values; it tends to decrease the development potential, for agricultural, industrial, residential, recreational, and other uses, of large areas of land; it changes the physical characteristics of lakes, rivers, and other water bodies to the point of interfering with navigation.

The origin of Federal policy on water pollution control reflected concern for the fostering and protection of navigation. The first specific Federal water pollution control legislation was enacted in 1899 solely for preventing impediments to navigation. Sanction for such exercise of Federal power resides in the so-called "commerce clause," Article I, Section 8, Clause 3, of the U.S. Constitution, which provides that "The Congress shall have Power * * * To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes." This clause has been interpreted to give Federal jurisdiction over all navigable waters of the United States, including coastal waters.

The next chapters of Federal policy development on water pollution reflect concern for the prevention of disease and certain economic values. The Public Health Service Act of 1912 contained provisions authorizing investigations of water pollution related to disease. The Oil Pollution Act of 1924 was directed to control oil discharges in coastal waters causing damage to aquatic life, harbors and docks, and recreational facilities. Sanction for the earlier of these enactments exists in the so-called "general welfare" clause, Article I, Section 8, Clause 1, of the U.S. Constitution, which provides that "The Congress shall have power to lay and collect Taxes * * * to * * * provide for the * * * general Welfare of the United States * * *." The concept of the general welfare has been construed broadly enough to encompass, within this limitation on the taxing power, authority to tax and spend to provide protection for all the uses of water with which pollution can interfere.

In addition to the foregoing direct considerations which have conditioned a Federal responsibility for water pollution control, there is an indirect reason on which to found such responsibility. This lies in the close association between water pollution control and other major areas of well-established Federal responsibility which argues imperatively against leaving water pollution control solely to the States. These other areas include management of the public domain, water resource development, public water supply, mineral resource development, agriculture policy, transportation policy, general industrial development, navigation (including river and harbor development), electric power development, irrigation, flood control, drainage, fisheries and migratory waterfowl conservation, outdoor recreation development, soil and moisture conservation, etc.

## III. Some Considerations Affecting the Formulation of National Water Pollution Control Policy

Having identified the factual basis and constitutional sanctions for a Federal responsibility in keeping our waters clean, let us turn to the consideration of a national policy for water pollution control and the programs and activities to be engaged in to make such a policy effective. To do so we must consider in somewhat sharper focus the nature and origin of the problem of water pollution which is, of course, only a part of the broader problem of water resources.

A detailed review of the water resources problem of the United States from now on is beyond the scope of this paper. There are available in many sources ample factual information, forecasts, and analyses which serve well to show that water has become one of our chief natural resource problems. In summary, we may say that our problem as a Nation is that of making the relatively fixed supply of water meet a rapidly increasing demand by providing the right quantity of water of the right quality when and where it is needed. As time goes on, the element of quality control is going to be crucial in achieving this objective. It has already become so in many particular areas.

Today it is commonplace to observe that the pollution of the Nation's water resources constitutes an economic and social loss. The actual extent of these losses, however, are unknown. The social and economic costs of pollution derive from its adverse effects on the usefulness of water. All the uses of water are impaired to some extent by pollution, and some impairments positively prevent certain activities. Gross pollution prevents most recreational activity. The signs posted by health officials warning bathers of the hazards at particular polluted sites are manifestations of this situation.

Limitations on industrial development because the quality of the water is too poor for use in certain industrial operations is an example of impaired activity due to water pollution. Another example is the change in aquatic life caused by pollution and its implications for fishermen. Oftentimes game fish will be displaced by rough scavenger types under this condition.

Use for water supply for municipal purposes is also frequently impaired, forcing some communities to use a more distant and therefore more costly—and perhaps contested—supply than the one at their front door.

Agricultural uses, such as stock watering and irrigation, may also be hampered by pollution. Some navigational handicaps are incurred through pollution, such as corrosive action of mine drainage and some industrial chemicals on ships' hulls and navigational structures.

The adverse effects are not confined to these direct uses of water. Land uses associated with water are also involved. A conspicuous instance of this form of impairment is the decline in land values of residential sites along polluted waterways. The attractiveness of camping and other outdoor recreational activities is diminished in proximity to water-polluted areas.

It is evident from the instances cited that the value of water derives from its many uses and the absence of any reasonable substitute for most of these uses. The condition or quality of water, moreover, is an essential feature of its usability. Thus, it is quality as well as quantity that is necessary for an adequate supply of water. Pollution affects the great versatility of water by lowering its quality, thus reducing its usability and therefore its value. In this sense, pollution reduces the supply of water.

The foregoing discussion is intended to give us greater insight into the social and economic aspects of the problem of water pollution. Around each water use there are groups of water users ranging from individuals and corporations in the private realm to municipalities, the community, and the Nation in the public realm. Together, the groups compose the broad general public, but each component is affected in a peculiar way, according to the kind of use and the extent of its impairment by pollution. The total social and economic loss is composed of the several losses of these varied groups. The groups are actually innumerable, for they involve the multitude of water sources of the Nation and vary even according to particular points in such sources. Therefore, the losses or damages from pollution are diffused throughout the entire society. Some of the effects are reflected directly in the payments for the construction, operation, and maintenance of water treatment facilities. By far the larger share of the total is not directly accounted for at all, however. The impairment to health, the loss or diminution of fishing and recreational uses, and the curtailment of property development are in this category. These consequences of pollution are not readily expressed in dollar terms. Nevertheless, such consequences are real and constitute a handicap to the fulfillment of economic and social goals.

Pollution control measures are designed to alleviate or eliminate such handicapping consequences. They result, in a very real sense, in the expansion of the supply of water, for the improvement of quality permits and facilitates the reuse of water. The reuse characteristic of water is perhaps its most prominent economic feature, and the enhancement of this feature is the objective of pollution control. Quite aside from the positive considerations of health protection, it is imperative to achieve this enhancement of usability because it is impossible to provide virginal water for all uses everywhere. There is just not enough water, without reuse, to meet the present and future demand situation. The forces creating this condition are already hard at work and will continue so: (1) a growing population with its increasing demands on our water resources, and (2) a growing and ever-maturing industrial technology with its increasing demands on and threats to our water resources.

The economic and social benefits obtained by pollution control are often not apparent to the public. Some of the benefits are indirect or intangible; others constitute insurance for future considerations. Generally, the communities which bear the tax burdens for waste treatment plants do not reap the gains from improved water quality. The lack of a demonstrable and direct economic or social gain to the community making the payments for treatment works has been a handicap in achieving pollution abatement. Yet, there are many instances where communities were passed over as locations for new industrial enterprises because the community did not provide sewage treatment. This omission therefore has proved to be an economic and social handicap. Apparently, among the marks of an acceptable community is the cleanliness of the physical environment and the attitude of the community toward its neighborhood responsibilities. In this context, a polluted water source is a liability.

Though many of the benefits from pollution control are as self-evident as the one just described, and many of these benefits accrue also to industry in the form of good quality industrial water, the monetary calculation of these benefits faces similar difficulties as the computation of losses. That is, the dollar measurement problem has not been solved and a yardstick for actions or events not recorded by market transactions is lacking. Many of the benefits from pollution control are in this nonmarket realm; e.g., enhancement of fishing and recreational opportunities, protection to health, scenic improvement, and assurance of the future utility of water resources for various other purposes. The market system therefore cannot be relied upon solely or chiefly to identify or measure the benefits obtained by pollution control. New devices for taking into account the social and economic values will need to be invented. These devices will be applied to answering such important questions as—

> What does water pollution cost a community, a region, or other areas in losses for all consequences?
>
> What are the specific benefits from alleviation of these losses and what is their economic worth?
>
> Who will benefit from the abatement of pollution and to what extent?
>
> How much can be justifiably spent in abating a pollution situation?
>
> How should the cost of control be apportioned among the members of the community, the region, and the Nation?

Answers to such questions are essential for sound formulation of water pollution control policies and planning of water pollution control programs. However, answers to such questions based on empirically derived formulations in the fields of public health, resource conservation, recreational development, or economic development are likely to elude us for many years to come. Even when measurement obstacles are overcome, we will only have taken a step toward gaging the dimensions of the problem of water pollution and acquired a perspective for comparing it with other governmental responsibilities and developed a rationale for allocating the costs of pollution and pollution control.

While we search for such answers, we must work vigorously for cleaner water, keeping clearly in mind how closely the water pollution situation can be judged in the conventional concept of supply and demand for water. The demand is increasing for a multiplicity of competing uses with a variety of quality requirements. The supply is relatively fixed and must be considered in terms of quality as much, if not more than quantity. Pollution reduces the supply; pollution control adds to it in terms of usability. Accordingly, the importance of pollution control is of the first magnitude, for it is the key to adequate water supplies for the future.

Most of our present water pollution problems are the result of too little attention in the past. Many States have not been provided with the programs and program resources commensurate with their pollution problems or their historic role of primary responsibility in dealing with pollution. The Federal Government has dealt with the problem only in recent years. Some municipalities and industries have resisted constructing needed waste treatment works, regarding them as a benefit only to the fellow downstream and as an unnecessary or unbearable financial burden. The public has been indifferent to the problem or has been allowed to retain too much of the "water purifies itself every 7 miles" philosophy. It has been oversold on the cheapness and plentifulness of water and undersold on the necessity for and value of pollution control. Society has relied on the stream to do much of the waste treatment job rather than having tailored treatment to keep the stream as clean as possible.

That we have not taken seriously enough the task of keeping our waters clean is reflected in the current level of our expenditures to prevent and control water pollution. We are as a Nation currently spending approximately $775 million annually from all sources for this purpose. Approximately $550 million of the total is going into the construction of waste treatment facilities; another $200 million is spent for the operation and maintenance of these facilities; about $20 million is going into other water quality program operations and regulatory activities; and the balance of less than $5 million goes for research into water pollution and its control.

The fundamental premise of our national water pollution control policy must be that as a Nation there is ample justification for very substantial enlargement of our investment in keeping our waters clean. Accordingly, it is imperative that we frame the responsibilities of government at all levels, of industry and of the public, for keeping water clean within a broad national policy which most efficiently and thoroughly encompasses the needs, desires, and expectations of all our citizens regarding the use and enjoyment of our natural water resources.

### IV. Scope of National Water Pollution Control Policy

National policy on water pollution control should be comprehensive in its scope of coverage of water uses.

Section 2 of the Federal Water Pollution Control Act lists five broad purposes for which natural waters may be used, adverse effects on which by polluting discharges is sought to be avoided through the operative provisions of the act. These water use purposes to be conserved are—

(i) public water supply;
(ii) propagation of fish and aquatic life and wildlife;
(iii) recreation uses;

(iv) agricultural uses;
(v) industrial uses.

To these five the draftsmen added a sixth, "other legitimate uses," presumably to correct any oversight which might have resulted from the itemization.

The Act is therefore satisfactory in authorizing the Federal Government to act with regard for interference with any and all legitimate water uses, whatever purpose they may serve.

The same cannot be said for the authority of other levels of governmental responsibility. Not all our States or local communities have authority for a comprehensive concern for clean water. This situation should be remedied. All public agencies having responsibility for prevention, abatement, or control of water pollution should be authorized to exercise their responsibility with reference to all legitimate water uses.

The foregoing prescription of the scope of governmental concern about water quality comprehends the proposition that any degradation of water which can interfere with its legitimate use is contrary to national policy. Although I believe this policy is implicit in the Federal Water Pollution Control Act, I regard it as so fundamental that I recommend the Act be appropriately amended to make this explicitly clear. The laws of some of our States are similarly in need of clarifying amendments to this effect. In many other States the laws need to be amended to establish rather than just to clarify this important policy principle. No water pollution control law should by its terms or by interpretation be held to require, permit, or condone any type of water pollution.

The use of our watercourses for waste disposal cannot be ignored. This use dates from antiquity. Our practice in water quality management has been to regard the use of rivers, lakes, and other waters as appropriate means of waste disposal. Such use has derived from the necessity of disposing of water after many of its uses. Indeed, it is not possible to utilize water for domestic, municipal, and most industrial purposes without providing some method of disposing of it afterwards. The only place available for disposal is the watercourses, for, except for consumptive uses, the volumes to be disposed of are roughly equal to the volumes originally diverted.

To a considerable extent we have in the past been able to use our watercourses for waste disposal, in the process of returning to them water we have used, without serious interference with other water uses. Because of this circumstance, however, I fear there are some who believe that disposal of polluting waste through used water discharge is a legitimate use of water, consistent with water pollution control policy. Indeed, the very term "pollution control" invites such an attitude since the word "control" implies limitation rather than elimination of pollution.

Whatever may have been acceptable or unavoidable in years past, it is quite clear that our goal now and in the years ahead must be to prevent any sort of water pollution, and our water pollution control laws should explicitly so provide.

## V. Governmental Programs and Activities To Carry Out National Water Pollution Control Policy

The next element to be considered in delineating a national water pollution control policy is the determination of the type of programs and activities which should be undertaken by government at all levels as part of its responsibility for keeping water clean. These, it seems to me, fall into two broad categories which, while separable as a matter of analysis, must in practice be regarded as having a high degree of interaction. Broadly speaking, I will designate these as promotional and regulatory.

Under the caption "promotional" much can be done by government by way of acquisition of information, research, training of people, development of methodology, provision of facilities and equipment and public education all of which will promote the maintenance of our waters sufficiently free from impurities so as to permit their legitimate use for all the purposes already mentioned.

Under the caption "regulatory" would be grouped governmental action designed to limit, by complete or conditional prohibition, the practice by individuals, municipalities, industries, or government installations of causing or contributing to water pollution.

Because of constitutional limitations, the scope of regulatory activities which can be a part of the Federal Government's responsibility probably cannot in all respects be as broad as the scope of Federal promotional programs. Authority for the latter stems constitutionally from the "taxation-general welfare" clause, which imposes relatively little limitation on the scope of Federal authority compared to the scope of authority for Federal regulatory activities. The latter authority stems from the "commerce" clause which, although it has been construed with great elasticity in recent decades, imposes significant limitations on the reach of Federal action.

### A. *Promotional Programs*

Let us first consider promotional programs. What should government do to promote clean waters? Fundamental is to have information on the basis of which to plan and carry out programs. A thorough understanding of the processes whereby water is degraded is necessary. Comprehensive information is needed about what uses are being made of water and in what condition it is being discharged to its courses after use. Continuous and thorough data regarding the location of water supply, its quantity, flow, and quality must be recorded so long as any degrading uses of water must be tolerated. Thorough knowledge must be gained of how to treat used water before it is returned to its courses, working always toward the goal of finding effective and economical means of eliminating all pollutants.

The technology of treatment facilities must keep pace with research findings about effective treatment techniques. In the case of substances whose use is important or cannot be avoided but for which no satisfactory treatment techniques have been discovered, ways must be sought for isolating them from the flow of municipal, agricultural, and industrial wastes.

Knowledge and technology are useless without adequate facilities and trained personnel to apply them. These should be deployed in such a way as to assure that they will be brought to bear most expeditiously and efficiently in all efforts to preserve water quality.

1. *Present Federal promotional programs.*—The basic Federal promotional programs are authorized by the Federal Water Pollution Control Act, which requires that they be carried out by the Surgeon General under the direction and supervision of the Secretary of Health, Education, and Welfare.

*a. Development of comprehensive programs for water pollution control.*—Under section 2 of the Act, in cooperation with other Federal agencies, State and interstate water pollution control agencies, and with the municipalities and industries involved, comprehensive water pollution control programs are required to be developed which give due regard to conservation of waters for all legitimate purposes.

This is probably the most important program specified in the Act since the goal of all water pollution control activities is the development and implementation of comprehensive programs to conserve water for its best uses. All of the other major provisions in the Act largely support comprehensive programs.

Comprehensive programs require a determination of the causes of water pollution, and their effects on quality of the water resources and on the beneficial water uses. They develop agreements on the desired beneficial water uses and the water quality objectives necessary to accommodate these uses. They outline the pollution control measures that must be provided to achieve the desired objectives and a timetable for their accomplishment. They provide for orderly and efficient water quality control in the development of the Nation's water resources and are needed for every river basin in the country.

*b. Technical assistance.*—The Public Health Service has been providing technical services to State and interstate agencies and other Federal agencies for nearly 50 years.

The Act greatly broadened the technical services to be provided by the Public Health Service—actually, all its major provisions can be regarded as technical assistance. Section 4(a) of the act requires that—

> The Surgeon General shall conduct in the Public Health Service and encourage, cooperate with, and render assistance to other appropriate public (whether Federal, State, interstate, or local) authorities, agencies, and institutions, private agencies, and institutions, and individuals in the conduct of, and promote the coordination of research, investigations, experiments, demonstrations, and studies relating to the causes, control, and prevention of water pollution.

Obviously, the technical services to be provided are very broad and no agency or individual having concern with water pollution is excluded.

In rendering technical assistance, the Surgeon General is specifically authorized to—

i. Upon request by any State or interstate water pollution control agency, conduct investigations and research, and make surveys concerning any specific problem of water pollution confronting such agencies, or a community, municipality, or industrial plant. (Sec. 4(b) of the act.)

ii. Provide training in technical matters relating to the causes, prevention, and control of water pollution. This can be done by direct training by the Service, by grants-in-aid to or by contract with public and private agencies and individuals, and by the establishment of research fellowships (sec. 4(a) (4) and (5) of the act.)

iii. Collect and make available, through publications and other appropriate means, information on research, demonstrations, and investigations, including appropriate recommendations. (Sec. 4(a)(1) of the act.)

*c. Research.*—Under section 4(a) of the Act the Surgeon General is required to conduct water pollution research within the Service and to encourage, cooperate with, and assist other appropriate agencies and individuals in such research. In accomplishing this, he is authorized to (1) carry out research relating to the causes, control, and prevention of water pollution; (2) contract for research with public and private agencies and individuals; (3) make grants-in-aid for research and demonstrations to such agencies and individuals; (4) secure the services of research experts and consultants; (5) establish and maintain research fellowships; and (6) collect, publish, and disseminate information on the results of research.

*d. Basic data.*—Section 4(c) of the Act provides that the Surgeon General shall collect and disseminate basic data on chemical, physical, and biological water quality and other information relating to water pollution, in cooperation with other Federal, State, and local agencies having related responsibilities.

Basic data are needed for the intelligent planning and management of water pollution control. Such data furnish necessary information on: (*a*) the sources, kinds, and amounts of pollution; (*b*) the effects of pollution on water quality; (*c*) the present and future required uses of the affected waters; (*d*) the remedial measures needed to accommodate the required water uses; (*e*) the kinds, costs, and efficiencies of the remedial measures; (*f*) the costs and benefits of pollution and its control; (*g*) long-term water quality trends; (*h*) potential pollution situations before they become serious and require major action; (*i*) comprehensive program developments and enforcement actions; and (*j*) areas of vitally needed research.

*e. Construction grants.*—Section 6 of the Act provides for the appropriation of $50 million annually up to an aggregate of $500 million for grants to municipalities for the construction of treatment works, no individual grant to exceed 30 percent of the estimated cost or $250,000, whichever is smaller. The administration of the program of grants to municipalities for the construction of sewage treatment facilities is a joint responsibility of the Public Health Service and the States.

To meet its responsibilities for the equitable and efficient administration of the construction grants, the Public Health Service maintains technical staffs in each of the Department's nine regional offices. These staffs: (1) review and approve grant applications for eligibility; (2) determine propriety of Federal aid in accordance with criteria adopted for this purpose; (3) give technical review and approval of construction plans and specifications; (4) make field inspections of projects under construction for payment purposes; and (5) keep records. The headquarters office in Washington provides policy and program guidance and renders decisions only on matters which cannot be reconciled in the field.

*f. Program grants to State and interstate agencies.*—Section 5 of the Act provides for $3 million annually in grants for State and interstate agencies to assist them in meeting the costs of establishing and maintaining adequate water pollution control programs. These are matching grants, in effect, for the States are required to provide from one-third to two-thirds of the costs of their programs, and were intended to have a stimulatory effect on State appropriations for water pollution control.

Public Health Service responsibilities in administering the program grants include allotment of funds and approval of State and interstate water pollution control plans as required by the act. Regional office personnel work with the States in developing program improvements and make evaluations of progress. The program grant authorization expires with fiscal year 1961 unless extended by amendment of the Act.

*g. Cooperation to control pollution from Federal installations.*—Section 9 of the Act directs Federal agencies to cooperate with the Department of Health, Education, and Welfare, and with States, interstate agencies, and municipalities in controlling pollution from Federal installations. Public Health Service responsibilities under this provision include inventorying such pollution, providing technical and consultative services to all the jurisdictions involved, acting as liaison between jurisdictions as necessary, and providing research services and field investigations.

*h. Interstate cooperation and uniform laws.*—Section 3(a) of the Act directs the Surgeon General to encourage: (1) cooperative water pollution control activities by States; (2) the enactment of improved and, where practical, uniform State laws; and (3) compacts between States.

2. *Need to strengthen present promotional programs.*—Our current promotional programs to prevent and control water pollution leave much to be desired in terms of results. Our basic knowledge about water quality degradation is not keeping pace with the progress of industry in developing new, exotic chemicals and radioactive substances. While we are reasonably well informed about the configuration of municipal waste disposal, we are not adequately informed about what agriculture and industry are doing to our waters. In spite of the great strides which we have made in the first 3 years of operation of the National Water Quality Network since its initiation in October 1957, there is much room for improvement in the completeness of our data on the chemical, physical, and biological quality of waters and in our ability to make effective use of these data. We especially need added knowledge about underground waters and the fate of soluble materials therein.

Although we have learned much about how to remove oxygen-demanding substances, suspended solids, and disease-producing organisms from wastes, we have barely scratched the surface of learning about the removal of dissolved materials, especially the new synthetic organic chemicals. Our knowledge lags in nearly all aspects of waste treatment.

We are handicapped in accelerating progress, in increasing our knowledge and improving our technology by insufficiency of trained personnel and research and technological facilities. The Robert A. Taft Sanitary Engineering Center at Cincinnati, Ohio, is the largest and finest research and technological facility of its kind in the world, and it is staffed by leading scientists and engineers in the field of water pollution. Since its completion and initiation of operations in 1953, the Center has conducted steadily expanding programs of research, technical services, and training of scientists, engineers and other essential specialists. In spite of this, the resource represented by the Center is small compared with the problems confronting us.

In these remarks about the need to strengthen promotional programs, I have been speaking of Federal programs conducted under the Federal Water Pollution Control Act. The condition of corresponding promotional programs among the States also is in great need of strengthening. It should, of course, be noted that much has been done to this end by means of the program grants made under the act to State and interstate agencies. One measure of such progress is the increase since 1956 in the level of State appropriations for water pollution control programs from $4.2 million to $7.6 million for fiscal year 1960. Another is the almost 50 percent increase of their technical and supporting staffs by State and interstate agencies. These increases have made possible the initiation and expansion of pollution surveys, research, and basic data collection. Also, program grants have made possible the purchase of major items of field and laboratory equipment needed to support expanding programs.

In short, State programs have been strengthened under the Act, but there is always room for improvement. In this connection it seems clear that the present section 5 authorization for State and interstate agency program grants should be extended beyond its present June 30, 1961, expiration date. I would also urge consideration of the removal of the appropriation ceiling of $3 million.

3. *Suggestions for strengthening promotional programs.*—How else shall we accelerate our progress in the foregoing promotional programs?

*a. Strengthen the arms of research and technology.*—First, there should be an expansion of programs of research and fundamental technology within the Public Health Service, by contracts and grants-in-aid, and through fellowships. This is a pattern of primary Federal responsibility in areas of national concern which is already well established. Indeed, it is essentially the present situation in the field of water pollution.

*b. Regional laboratories.*—Second, as the research and technological program in the field of water pollution is expanded by the Public Health Service, I would recommend consideration of a more localized activity through the establishment of a number of regional service laboratories. Such an approach could afford more effective, firsthand, and comprehensive approaches to specific pollution problems than is possible through centralized facilities. It would enable closer collaboration between Federal programs and field services and those of State, interstate, and municipal agencies, industries, universities, and others concerned with water pollution problems. It would enable a more effective marshaling of total resources in various areas of the country for application to problems. It would facilitate the stimulation of greater awareness and understanding on the part of the general public of the significance of maximum conservation in the use of our limited, available water resources for their own health, economic welfare, and recreational opportunity. It would afford a better means of segregating basic research and fundamental technology centered in Cincinnati from applied research and engineering essential to the solution of specific field problems and the conduct of regulatory activities.

A pilot facility such as the one I have described might well be established to test the validity of such an approach.

Regional laboratories could be strategically situated throughout the Nation with respect to water pollution problems of the major river basins; the resources of other Federal agencies; interstate, State, and local agencies; universities and research institutions; and transportation facilities.

c. *Personnel resources.*—My third suggestion is to mount a continuing survey of personnel resources in the area of water quality management. We are suffering an acknowledged and serious shortage of scientific, engineering, and other specialized manpower in this whole broad area. The survey should be conducted by the Public Health Service in cooperation with the States, industries, and research institutions, and should measure the extent of our present shortage, project our needs into the future, and keep a spotlight focused on any gap between future needs and predicted output from educational institutions. If such a survey demonstrated the need, consideration could then be given to establishing appropriate programs of graduate fellowships and vocational education to assure us against personnel shortages. By keeping track of employment conditions in the area of water quality management, the survey would also help to assure that qualified persons in sufficient numbers will embark on and continue careers in this work to meet our needs in the crucial area of public health programs.

d. *Industrial waste pollution.*—My fourth suggestion is that we develop more effective ways of learning about industrial waste pollution. Much has already been done—but much more needs to be done. This will demand a team effort, with industry and Government playing key research roles. Armed with this knowledge, we will do a more effective job of abating industrial pollution.

Although it has not been possible as yet to quantify the economic significance of industrial water pollution, in view of the size and composition of industrial production and the very considerable extent to which industrial wastes are discharged untreated to surface waters, it is generally assumed that the economic significance of industrial water pollution is at least as large as pollution caused by domestic wastes. It seems reasonable to assume that progress in understanding the economics of water pollution will lead to a more intensified program by industry as a whole to return water to its course in as good condition as it was withdrawn.

However, the campaign to abate industrial pollution cannot be founded solely on the basis of an economic justification. The national interest in cleaning up and keeping clean our natural waters transcends particular industrial economic interests.

It is quite likely that the most effective stimulant to progress in abating and preventing industrial water pollution lies in regulatory activities which are considered later in this paper. Nevertheless we must also design our promotional programs so as to make maximum use of them to achieve this goal. In this connection we might also consider what sort of financing assistance through credit accommodation, tax, or other incentives might be devised to stimulate greater water pollution control activity by industry.

*e. Construction of waste treatment facilities.*—Finally, we come to suggestions concerning the construction of facilities to treat wastes before they are discharged to our lakes, rivers, and streams. Under the Federal Water Pollution Control Act, under State laws and under the charters and ordinances of municipalities, it is clear that primary responsibility for the provision of waste treatment facilities lies with local communities and with individual industrial concerns and private individuals.

It is, however, significant to note that under the Federal Act, and also under several State laws, provision has been made for sharing of this responsibility by the Federal Government and by the States.

The Federal facilities construction grant program was written into the present Act in lieu of a loan program which had been authorized in the Water Pollution Control Act of 1948 to help finance construction of sewage treatment plants. No funds were ever appropriated by the Congress for the earlier loan program. Under the present Act, annual appropriations for the grant program are limited to $50 million per year, with an aggregate limitation of $500 million. When the Act was passed, a 10-year program at $50 million per year was envisaged. Appropriations have been made at the rate of $45 million per year for each fiscal year from 1958 through 1961. As of November 1, 1960, a total of 2,418 Federal grant offers to municipalities have been made in support of projects costing an estimated $1,169.9 million. The Federal grant offers totaled $199.6 million, contrasted with State and local commitments of $970.4 million, showing a local-to-Federal dollar participation ratio of 4.86 to 1.

Before further consideration of the waste treatment facilities construction grants program, we should note that it represents only one portion of the Federal program for promotion of clean water by financial assistance to facilities construction. The other portion is a loan program administered by the Community Facilities Administration of the Housing and Home Finance Agency. Under this program local public agencies may finance construction of needed public works through long-term, interest-bearing loans when such loans are not otherwise available on reasonable terms and conditions. Priority is given to assisting communities with a population of less than 10,000 in the construction of basic public works for which there is an urgent and vital public need, including works for the storage, treatment, purification or distribution of water; sewage, sewage treatment, and sewer facilities; and gas distribution systems. Since the establishment of the Community Facilities Administration in 1955, it has, as of November 1, 1960, made 260 loans totaling $66 million for water and sewer projects.

A final observation to be made about the present pattern of governmental responsibility for financing of construction of waste treatment facilities is to note that several States have enacted various programs designed to assist municipalities or industries. These include tax relief for industries, in the form of property tax exemption for such facilities and accelerated amortization of the cost of such facilities for tax purposes, and financial assistance for municipalities in the form of planning and construction grants and guarantees of municipal bond issues.

Under the national water pollution control policy recommended in this paper, it is proposed that primary responsibility for the construction of waste treatment facilities remain, as it is under present national policy, with local communities. On this point the logic of President Eisenhower's statement in his message disapproving H.R. 3610 of the 86th Congress is persuasive. He wrote in part as follows:

> Polluted water is a threat to the health and well-being of all our citizens. Yet, pollution and its correction are so closely involved with local industrial processes and with public water supply and sewage treatment, that the problem can be successfully met only if State and local governments and industry assume the major responsibility for cleaning up the Nation's rivers and streams.

Working from the starting point of placing primary responsibility on local and State governments, we can also see the need for supplemental action by the Federal Government.

We need a vigorous program of abating pollution from Federal installations. This will require firm leadership within the executive branch together with willingness on the part of the Congress to provide necessary funds.

A start has been made by the declaration of congressional intent in section 9 of the Federal Water Pollution Control Act which recites in part that—

> any Federal department or agency having any jurisdiction over any building, installation, or other property shall, insofar as practicable and consistent with the

> interests of the United States and within any available appropriations cooperate * * * in preventing or controlling the pollution of such waters.

The Public Health Service is currently engaged in making an inventory of waste disposal conditions at all Federal installations. This inventory was directed by President Eisenhower's memorandum to the Secretary of Health, Education, and Welfare dated May 13, 1960. The memorandum read in part as follows:

> It seems to me that the Federal Establishment must take every possible action to make certain that its own house is in order with reference to the problem of controlling and preventing stream pollution.
>
> I should * * * like you to take the lead in making an inventory of the pollution control situation at Federal installations. This inventory will assist each Federal agency concerned in determining what corrective actions may be required and how rapidly they could be accomplished to eliminate those conditions which may be contributing to the pollution of waters. It seems quite clear to me that such an inventory, combined with the national inventory of water pollution control facilities, is an essential step toward the initiation of corrective actions.

As soon as data from this survey are available, a schedule of pollution abatement through construction of waste treatment facilities at all Federal installations discharging untreated wastes directly to our natural waters should be established and funds sought from the Congress to carry it out. There can be no justification for a failure of vigorous leadership to abate pollution at Federal installations.

If we are to stimulate the construction of waste treatment facilities, we must review carefully the Federal role from the standpoint of our pollution abatement and prevention needs, the financial requirements to meet the needs, and the results so far attained. This must also be looked at by the new Congress from the standpoint of whatever fiscal policy is adopted by the new administration. I would not presume at this point to suggest as a matter of overall Federal fiscal policy what should be the level of funding of the construction grants program.

I would recommend amendment to section 6, as H.R. 3610 and the administration's subsequent bill in the 86th Congress (S. 3574, H.R. 12309) would have done, in the case of a multimunicipality project, in effect to multiply the individual project grant ceiling by the number of municipalities to be served by the project. This change would facilitate planning and construction of projects serving metropolitan areas rather than individual communities, and provide for more economical use of public funds.

Serious consideration should also be given to changing the present individual project grant ceiling for waste treatment projects so as to give the program a stimulative effect in large municipalities.

Finally, it would be desirable to review all the present provisions of Section 6 in the light of experience under them to determine whether there might not be other improvements which could be made at the time the foregoing suggestions are considered.

### B. *Regulatory activities*

Now let us consider regulatory activities in service of water pollution control policy. As suggested earlier, such activities have the effect of curbing or prohibiting the disposal of wastes and waste waters whose effect is to degrade the water quality of our lakes, rivers, and streams.

These activities generally take the form of exercise of enforcement authority to abate pollution declared illegal by law or issuance or denial of applications for permits or licenses required for the discharge of sewage and industrial wastes.

In all discussions of water pollution control policy, the subject of Federal regulatory activities has tended to be highly contentious with political sensitivity for current pollution practices. The issue has usually been drawn on what should be the nature and scope of the Federal Government's authority to take enforcement action to abate pollution. This is the only specific regulatory activity authorized for the Federal Government under our present national water pollution control policy.

Under the Federal Water Pollution Control Act, Federal enforcement authority applies to pollution of any interstate waters, which the Act defines to include "all rivers, lakes, and other waters that flow across, or form a part of, boundaries between two or more States." Under this definition almost all coastal waters are excluded; so are waters which, though they may be navigable, do not cross or form part of State boundaries.

Federal enforcement authority covers only pollution of interstate waters, defined as above, which "endangers the health or welfare of persons in a State other than that in which the discharge originates * * * ." This is the only pollution which is subject to abatement under the Act.

The effect of this limitation is to put Federal enforcement officials into our waters to trace the noxious effects of some polluter's discharge through the discharges of often hundreds of other polluters to some point in another State where the effect can be segregated from its host of acquired companions and found to endanger the health or welfare of persons. The enforcement process is then, by reason of the wording of the act, intrinsically slow, expensive, and far less efficient than possible.

Twelve enforcement actions have been initiated under the Act to abate pollution in over 4,000 miles of interstate streams. It is estimated that the remedial measures which will have grown out of these actions will include construction of over $500 million worth of waste treatment facilities. These statistics alone give some indication of the significance of enforcement action as a stimulus to construction of waste treatment facilities.

In spite of these results, experience with the enforcement provisions of the present Act have led many to the conclusion that they can and should be strengthened so that enforcement may serve more broadly and more efficiently as a stimulus to waste treatment facilities construction. I agree. Two principal proposals were advanced to this end in the 86th Congress.

One was the administration bill (S. 3574 and H.R. 12309). The other was the so-called Blatnik-Dingell bill (H.R. 10243 and H.R. 10244, also introduced in the Senate as S. 2992). Each of these would have broadened the scope of Federal jurisdiction to abate pollution. The administration bill extended authority to abate pollution to coastal waters and to any interstate waters which are navigable without need for a showing of adverse effect in another State. The Blatnik-Dingell bill extended abatement authority to pollution of any navigable waters (including coastal waters) which endangers health or welfare of persons. Both bills also made various changes in the procedural provisions governing Federal enforcement action.

I believe that the Federal Water Pollution Control Act should be amended so as to utilize the full constitutional regulatory authority of the Federal Government so as to assure maximum potential stimulatory effect from Federal action to prevent and abate water pollution. This would mean extending the authority for Federal action to all navigable waters of the United States.

It should be noted that the scope of Federal jurisdiction for regulatory activities, even if extended to all navigable waters, will still fall short of covering all water sources within any given State. All nonnavigable waters, including all underground waters, would in such event be amenable only to State regulatory jurisdiction. The Federal Government can, however, and should, through its promotional programs, render assistance to States in the exercise of their regulatory authority over such waters.

# The Needs and Obligations of Interstate Agencies

EDWARD J. CLEARY
***Executive Director and Chief Engineer***
***Ohio River Valley Water Sanitation Commission***

Before discussing the role of an interstate compact agency in the administration of water-pollution control, it would seem appropriate to define the nature of a compact agency. The interstate compact is a unique device in our form of government for positive cooperation among States. It is as old as the United States itself, provision for its use stemming from Section 10 of Article I of our Constitution. Here the States retained the privilege of joining together for a mutually desired purpose—provided that the Congress of the United States gave consent to such an agreement or compact.

Thus provision is made for two or more States to establish a mechanism for resolving problems whose influence extends beyond the political boundaries of an individual State without burdening the Federal Government in the process. Control of pollution in streams that pass through or are contiguous to several States is one of the problems whose resolution has been sought by means of interstate compacts.

Without indulging in a review of ideologies relating to Federal or interstate control of water pollution, there is one point that deserves mention. It is the intent of the Congress, as expressed in the National Pollution Control Act of 1948 and the amended Act of 1956, that the Federal authorities encourage the formation of interstate compacts. At the present time there are seven interstate agencies recognized by the U.S. Public Health Service as engaged in water pollution control. All of them owe their existence solely to the initiative of the States involved; and the five that are devoted exclusively to pollution problems came into existence prior to enactment of the Federal law in 1948. If the Federal authorities have given any encouragement to the formation of new interstate agencies, the results have not yet manifested themselves.

Without any claim to be a spokesman for the interstate agencies who are actively engaged in pollution control, I would suggest that their role parallels that of the Ohio River Valley Water Sanitation Commission (ORSANCO), with which I am associated. The role of Orsanco is to coordinate and supplement the activities of eight States who have pledged faithfully to cooperate "in the control of future pollution and the abatement of existing pollution." It is my intention to describe how ORSANCO is performing this function.

But first it should be said that this voluntary desire of the sovereign States of Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia to pool their resources and powers for more effective control of pollution found expression in a compact that was signed by the Governors of these eight States on June 30, 1948. Among other things, the compact established a commission composed of three representatives from each State appointed by the Governor of the State, and three representatives of the Federal Government appointed by the President of the United States. It is the duty of the members of the commission to promote execution of this pledge of cooperation.

To achieve this end, the commissioners promptly and unanimously agreed on a matter of basic policy. Simply stated, this policy recognized that coordination and supplementation of State efforts offered the most expeditious avenues toward accomplishment. This policy did not ignore the grant of certain powers of enforcement; it simply put first things first. And as was profoundly observed at that time: "The Commission's power to invoke the strong sanction of enforcement is the best guarantee that only rarely will it have to exercise it." This has been the case in fact; on only two occasions in the 12 years of the commission's existence have the enforcement provisions of the compact been invoked; in both cases the action was inspired by States who concluded that they had exhausted their own remedies in dealing with cities polluting interstate waters.

## The Nature of Coordination

Several examples will illustrate the nature and scope of activities designed to promote coordination of pollution-control effort in the Ohio Valley.

One of the first matters of business to come before the commission was the adequacy of laws within each signatory State to enable it to carry out the obligations assumed under the compact. These discussions gave impetus and support to a complete overhauling of legislation in Kentucky and Ohio, as well as to amendment of pollution-control laws in several other States. By 1953, when amendments to West Virginia legislation became effective, every signatory could report that it had complied with a primary obligation set forth in the interstate agreement.

Recognizing that industrial enterprises held one of the biggest stakes in the water conservation program of the Ohio Valley, the eight States concluded that industry representatives should be invited to share in the development and promotion of pollution-control measures. Thus, in 1950, the executive committee of ORSANCO was authorized to explore with management representatives of industry how this might be accomplished. The result was the establishment of so-called industry-action committees, representing generic groups such as steel, coal, chemicals, oil refining, metal finishing, and paper manufacturing. For more than a decade these committees, aggregating some 150 members, have been participating in the review and formulation of measures to curb pollution. This activity has profoundly influenced coordination of effort among the States and their industries.

One of the satisfying accomplishments from this integration of viewpoints was unanimous agreement in 1955 on a statement of policy and procedure for industrial-waste control. The importance of this undertaking may best be understood by noting that control of industrial wastes has been distinguished by the widest variations in philosophy and practice. This situation was not unknown to the drafters of the Ohio River Valley Water Sanitation Compact. Consequently, they expressed their intent for regulation in broad terms to provide opportunity for the commission to deliberate on and develop procedures for carrying out this complex assignment. This is not the time or place to go in details, which are set forth in a four-page document issued by the commission. The point is that after some 2 years of analysis and debate, the States did agree on procedures that have permitted the pursuit of industrial-waste control in a rational and practicable manner.

These examples will be recognized as representing coordination in three vital areas of pollution-control practice—namely, legislative adequacy, industry relationships, and administrative philosophy. Meantime, a more obvious type of coordination was promoted in such areas as the establishment of sewage-treatment requirements for interstate waters. The compact clearly stated that no single standard of sewage treatment could be prescribed because of such variable factors as size, flow, location, character, self-purification, and usage of waters within the compact district. As a consequence the commission is called upon to conduct investigations and evaluate these factors before reaching decisions.

In carrying out this responsibility, the commissioners draw upon the combined wisdom of the chief engineers of the eight States who are organized as an engineering committee. This committee reviews staff studies, examines proposals, and develops recommendations for the guidance of the commissioners in establishing requirements that have an impact on the affairs of hundreds of municipalities. Such decisions have been made for the 981-mile Ohio River involving the interests of six States; for the Wabash River where two States are coordinating their control programs; and on the Monongahela River where two other States are concerned in the protection of water common to both.

Because this committee is composed of the chief engineers of State programs it has logically developed as the clearinghouse for coordinating a host of administrative and technical matters that contribute to effective functioning of both State and interstate affairs. Here, for example, ideas are exchanged on data assembly and evaluation, on staffing and organization, on improvement of survey and analytical techniques, and on the conduct of public relations and enforcement procedures.

### Supplementing State Efforts

In addition to promoting coordination, the commissioners of ORSANCO are constantly exploring and exploiting opportunities to supplement State efforts.

Perhaps the most important—certainly the most imaginative and productive—of this supplementation effort has been that devoted to creation of public awareness and support for pollution abatement. Facing up to the realities of generating positive response from millions of people and thousands of industries in the eight-State area, it was concluded at the beginning of the program that something more than technical surveys, research programs, and legal compulsions would be necessary. The conditions prevailing on the Ohio River dramatically supported this view. Less than 1 percent of the 3½ million people living along the river provided treatment for their sewage discharges in 1948 when ORSANCO was organized. This unhappy circumstance was not due to lack of laws or technical know-how. Basically it represented lack of citizen understanding and inspiration.

Therefore, a major part of staff effort, coupled with the vigorous support of individual commissioners and State-agency personnel, has been channeled into activities designated to motivate communities and industries to move more promptly in meeting their obligations for pollution abatement. What this has encompassed is detailed in an article that appeared in the June 1959 issue of the *Journal of the American Public Health Association* (pp. 757–761). Suffice it to say for the purposes of this statement that in less than 10 years the commissioners of ORSANCO could report that 95 percent of the population on the Ohio River had sewage treatment works in operation or under construction.

Obviously something had happened to cause a change in public attitudes—and with it the willingness to spend huge sums of money for clean streams. In this incredibly short period of time the States had emphatically reversed the trend of half a century of river abuse in the Ohio Valley. And this occurred during a period when other parts of the Nation were bewailing a stalemate in sewage-works construction and calling for Federal subsidies.

Perhaps the best indication of how the ORSANCO States feel about supplementing their efforts in maintaining public support for pollution control is the authorization of further activities in this direction. This action recognizes that an informed citizenry is the strongest ally in the fight for clean waters. Accordingly, ORSANCO has been charged with the conduct of an intensified "public affairs" program. This includes a series of documentary films on Ohio Valley pollution-control dealing with problems yet unsolved as well as with progress that is being made. These films are tailored so that the regional aspects of the interstate program are interspersed with a segment dealing specifically with situations in the State where it is to be shown. Thus, each of the eight States is supplied with a version of the film highlighting local affairs in relation to what is going on in neighboring States.

The public-affairs project is also designed to take further advantage of the public-service time made available by radio and television stations. Transcribed "action oriented" messages dealing with various aspects of the antipollution efforts of the State agencies are supplied to the 60 television and 400 radio stations in the ORSANCO area. In addition to supplying these transcriptions, the station managers are given the names of local members of the State staffs who are available to participate in discussions or other special programs that the station features.

In order to promote most effective use of the films, the transcriptions, and other material, the ORSANCO staff has conducted the first of a series of "clinics" for State public-relations personnel. Under the guidance of a consultant retained by the commission, techniques are explored and ideas exchanged in development of better methods of communication with the public.

Still another form of supplementary service sponsored by the signatory States is a valleywide river monitor and surveillance program, which is now in its 10th year of development. Through the operation of a network of some 40 monitor stations, ORSANCO headquarters receives continuous reports on river-quality conditions. This serves two functions. On the one hand, it is the source of vital data for the assessment of control measures. Perhaps of even greater significance, the monitor stations have permitted the establishment of an "alert" system whereby the State agencies and the users of river water are kept informed of unusual conditions so that appropriate corrective actions can be taken promptly.

Looking toward improvement of the "alert" potentialities of the system, the States have sponsored development of an electronic sentinel, the first units of which are now in operation. Perfection of the ORSANCO robot monitor holds the promise that the Ohio may be the first river in the world to be placed under night-and-dayvigilance for water quality protection. The importance of this innovation in pollution control practice may be appreciated by noting that more than 2½ million people obtain their water supplies from the Ohio and almost a hundred huge industries draw their supply from the river. In pioneering this new concept for safeguarding water supplies, the eight States have demonstrated the leadership potentials that can emanate from the pooling of efforts.

Considering further possibilities of supplementing State efforts, the commissioners of ORSANCO this year authorized expenditure of funds to employ personnel for assignment to the States. The object is to provide additional manpower during the summer months to ease the burden of checking compliance of municipalities and industries with interstate control measures. A trial during this past summer in one State indicates that this supplemental activity offers promising possibilities.

In the field of research and special investigation the commissioners have been most sympathetic in their endeavor to sponsor projects recommended by the States through their engineering committee. This year, for example, it was possible to authorize 10 contracts totaling $165,000. In addition, the ORSANCO staff carries out investigations that are considered to be of mutual concern to the States. Two of these are now nearing completion. One deals with an analysis of river conditions in the Pennsylvania-Ohio-West Virginia area during the shutdown of the steel industry; the other is a field demonstration of a taste-and-odor control proposal.

### By Way of Summary

These examples typify the manner in which one group of States has harnessed its interstate agency to provide coordination and supplemental aid in the voluntarily chosen task of promoting a regional program of pollution control.

The nature and scope of these activities reveal that an interstate agency can perform a host of needed services without intruding on the sovereignty and responsibilities that are delegated to the States alone. However, an interstate agency can accomplish only what its signatories are willing to have it accomplish. A compact among States is a pledge of good faith; how well that pledge is redeemed depends on the sincerity, the ingenuity, and the moral fiber of its participants. Thus the commissioners of a compact agency are the custodians of a great responsibility. In brief, they are the "conscience" of the signatory States as well as the inspiration for what these States can accomplish together. Therefore the effectiveness of an interstate agency in accomplishing its mission is a measure of the dedication of the men who serve it.

Among those who have rendered devoted service to the Ohio Valley compact, none is more distinguished than Ross H. Walker, present chairman of ORSANCO. A member of the commission representing the Commonwealth of Virginia since 1948, he recently expressed himself as follows:

> The great advantage of working through a compact is that the signatory States are in fact working with individuals who are neighbors. And solving problems as neighbors is much more satisfying than turning over the task to people whose background and interests may be quite remote from the area they are asked to serve.

These sentiments epitomize what might well represent the most important role of an interstate compact—namely, the opportunity for neighbors to pool their resources for solving mutual problems.

**Dr. WOLMAN.** Thank you very much, Mr. Cleary, for this very inspiring summary of what can be done, given purpose and enthusiasm, in an interstate group under a compact system. The record on the Ohio, I think, is well worth emphasizing and reemphasizing because it was described, as I recall, in 1935 and 1936 in one of our earliest reports of the National Water Resources Board, as a common open sewer. This has been quoted time and time again.

I think Mr. Cleary might very properly demand, as time goes on, that this description of the river be changed in the light of the accomplishments that he has pointed out.

# The Needs and Obligations of Metropolitan Agencies—Municipal

JUSTUS H. FUGATE
***City Commissioner, Wichita, Kans.***

At the outset I wish to acknowledge the invaluable assistance and advice of my colleague, A. E. Howse, former mayor of Wichita. Together we have fought battles of water supply and pollution control, and it is a matter of pride with us that Wichita now is entering the final phase of a long-range water supply program in which pollution control is an integral part for the benefit of ourselves and our neighbors downstream throughout the Arkansas River Basin.

I wish to acknowledge our joint indebtedness to Hon. Robert S. Kerr, the senior Senator from Oklahoma who also serves as the chairman of the Select Committee on National Water Resources of the U.S. Senate. We have drawn upon his current book, *Land, Wood and Water*, and upon the publications of the Senate Select Committee for many of the facts and figures presented by this paper.

During the past 150 years we have seen a steady growth and expansion of Federal interest in water and related matters. Single-purpose works have been replaced by multiple-purpose, maximum-use projects. Local concepts have been expanded into river basin development plans. Soil conservation, reforestation, and watershed programs slowly are beginning to change tributary streamflow; small dams are conserving water at the source; large dams and reservoirs are impounding water for future use and are providing the collateral economic benefit of multiple-purpose projects.

The Federal Government has spent $20 billion on water projects, and half this amount was spent in the last 10 years. Expenditures presently are running at the rate of a billion dollars a year. Some $6.6 billion in projects are now before the congressional committees seeking authorization. Some $6 billion in projects are now under construction for which appropriations are made on an annual basis. Some $10 billion in projects have been authorized, but no funds have been appropriated while these authorizations are gathering dust in the Bureau of the Budget.

In spite of the effort at the Federal level, and in spite of substantial effort at the municipal and State levels, there are not now under construction or even planned for construction, by all the public and private agencies combined, sufficient water projects to provide the amount of water of acceptable quality that we will require in 1975. The naked fact is the United States faces a water crisis.

Our population in 1900 was 75 million. Our population will reach 225 million by 1975 and 330 million by the year 2000. The municipal demand for water is sensitive to the changing habits of daily life and each turn of the screw of civilization requires more water. The farm home without running water used 10 gallons per capita daily, but a modern home with running water consumes 150 gallons per capita daily. Thus, we have not only the problems of a rapidly expanding population but also the additional factor of substantial increases in per capita use (*1*).

Until recently water development projects were concerned almost entirely with water volume. Withdrawal of water in 1955 was 240 billion gallons per day, of which surface water sources supplied 80 percent and ground water sources supplied 20 percent. By 1975 we will be withdrawing 450 billion gallons per day. The present upper limit of our water supply is the average of 1,200 billion gallons a day. At first glance, it would appear that the water supply of this country is adequate, but because the supply is variable in time, in place, in quantity, and in quality, national and yearly averages do not reveal the fact that 45 percent of our municipal water supply is inadequate. This means that 40 million Americans are teetering on the edge of a serious water shortage (*1*).

In 1900 we used 40 billion gallons of fresh water daily. Consumption has risen to 270 billion gallons daily at the present time and will reach 650 billion gallons daily by 1980. The current estimate of usable fresh water in lakes, streams, and reservoirs is 650 billion gallons daily. As a country we will soon reach the limit of our water supply and, because water demands will continue to rise in accordance with population increases and per capita use, it becomes abundantly clear that water needs can be met only by continued reuse of the available supply.

As a major beneficiary of water for navigation, flood control, irrigation, power, water supply, pollution abatement, conservation and recreation purposes, it is obvious that the municipality has both the urgent need and the direct obligation to keep water clean. The megalopolis or supercity is already here. It stretches along the

Atlantic seaboard from Boston to Norfolk. By the turn of the century much of the population of the United States will consist of great belts of cities. In 1900 about 35 percent of our population lived in cities and towns, but by 1950 some 60 percent were in the urban centers. By the year 2000 some 85 percent of our population will be living in the metropolitan complexes (*1*).

The combination of municipal and industrial water uses presents the largest single use of our available water supply. Municipal use may approximate 90 billion gallons per day in the year 2000. Industrial use as a whole will soon become our largest use of water, although projections do not distinguish clearly between municipal use and industrial use. In 1950 per capita water use for farming purposes was 664 gallons as against industrial per capita use of 560 gallons. In 1960 the position was reversed, with industry soaking up 850 gallons per capita to farm use of 766 gallons per capita. By 1975 the prediction is 1,195 gallons per capita for industry, with farm use remaining stable at 820 gallons per capita (*1*).

The scientific borderline which we have set up between sewage water and drinking water is a precarious one. We live on the edge of a human or mechanical failure in our water purification works that could bring pestilence upon us, and the danger grows every year. We have some 30,000 sewage and industrial outlets discharging waste into our streams. Of this number, 10,000 outlets drain municipal sewage systems serving more than 100 million people, and of this number more than 25 percent of the total sewage load has been dumped into our waterways without any treatment whatsoever (*1*). Many cities and industries are using our waterways for disposal purposes without any intention of complying with pollution abatement legislation and consider that paying a small fine occasionally is cheap disposal cost. This is not good citizenship; it is not good economics; and it is not good government.

Pollution degrades the physical, chemical, biological, bacterial, and esthetic qualities of water, the degree depending upon the kind and amount of pollution in relation to the extent and nature of reuse. Pollution can be just as effective as a drought or a consumptive withdrawal in reducing or eliminating a water resource.

Water quality mangement means providing the right quality of water in the right quantities for the purposes to be served and at the places where it is needed. Generally speaking, water quality management can best be accomplished by the prevention, control, and abatement of pollution. The most effective assistance we can give ourselves in the immediate water crisis is to clean up the water we have. As increasing demands are placed against our limited supplies, more usable water can be provided by the prevention and control of pollution than by any other means. It seems clear that we cannot permit uncontrolled and indiscriminate use of our water resources by any one individual, any one industry, any one municipality, or any one State.

Water quality management can be accomplished best when we recognize the river basin as the logical unit for water resources development, including pollution abatement. Progress will be made in direct proportion to the cooperation developed between municipal, State, and Federal Governments in matters of legislation, enforcement, financial assistance, research, intelligence, education and training, and public information. No single level of government can do the job alone and direct responsibilities can be assigned logically to each of the governmental levels.

### River Basin—The Basic Unit

Rainfall, evaporation, and transpiration continue in an unbroken cycle as water works its way slowly to the sea. The constant movement of surface and ground waters disregards entirely city limits, State boundaries, and national borders. Watershed drainage and tributary streamflow present difficult questions. The conflicts of English riparian water law versus Roman appropriation water law add confusion to the expanding and overriding interest of the Federal Government in its conflict with the State governments over water matters. All these factors added to the unique characteristics of water have been studied for the past 30 years by the legislative and executive branches of the Federal Government in cooperation with the States and by five different boards and commissions in the past 10 years including the two Hoover Commissions.

There is general agreement that water resources planning, development, and administration must be conducted on a regional or interstate basis with each of the major river basins as a comprehensive unit. The first efforts toward river basin planning were made by the National Resources Planning Board during the 1930's. The latest efforts are those of the U.S. Study Commissions created by the Congress in 1958 to undertake studies for the full development of all purposes of the water resources in Texas and the Southeastern States.

In between the National Resources Planning Board and the two new Study Commissions, other multiple-purpose planning programs have been undertaken such as the Tennessee Valley Authority program, the Coulee Basin program (Washington), and the Central Valley Project (California) in the 1930's; the Missouri Basin Development plan (Pick-Sloan plan) authorized in the 1944 Flood Control Act; and the Federal Inter-Agency River Basin planning studies of the New England-New York Inter-Agency Committee and the Arkansas-White-Red River Basins Inter-Agency Committee in the 1950's.

The reasons supporting river basin unit planning for water resources development purposes are obvious. Municipal jurisdiction is confined within city limits; State authority ends at the border of the State. Economic, legal, and political factors make it impossible for a single unit of government to develop a river basin resources program without the cooperation and participation of all levels of government concerned.

The transition from single-purpose navigation, flood control, and irrigation works to multiple-purpose, maximum-use projects is completely logical and is dictated both by the scarcity of adequate sites and by water economics. Once used, reservoir sites are gone for practical purposes and are not available for future water resources development. The Commissioner of Reclamation testified in public hearings before the congressional committees in 1959 that, with hindsight, the Bureau of Reclamation would now construct most of its single-purpose works as multiple-purpose works. There simply are not enough suitable water project sites available to permit loss of a single site from its maximum use. The Federal Power Commission has made a detailed examination of prospective reservoir sites and has concluded that even if all the sites were developed, less than one-half the 1975 demand for hydroelectric power would be satisfied (*1*).

As single-purpose flood control and irrigation works evolved into multiple-purpose projects, it became clear that the public interest could be served by including storage capacity for industrial and municipal water supply at substantially less cost than comparable storage could be constructed separately. Similarly the costs allocated on a reimbursement basis for water supply purposes in turn reduces substantially the project costs allocated to other reimbursable and nonreimbursable purposes. The expansion of water facilities into multiple-purpose, maximum-use projects is dictated by economics which indicate approximately 50 percent less construction cost for each benefit included in the works than might be occasioned by the separate construction of single-purpose works for each of the benefits.

The development of reservoir sites to their maximum use raises some question as to storage or benefits for future use as against immediate use. Obviously, no single municipality and no single State is in a position financially, legally, or politically to develop water resource sites to their maximum use for multiple purposes from which the present and future benefits will accrue to downstream users of water throughout the entire river basin. Conversely it makes no sense to permit a single municipality or a single State to develop water resource projects for local purposes only at less than maximum development of the site and to the ultimate detriment of the entire river basin area.

### Legislation

The authority of the Federal Government should be clarified, and if necessary, increased, not for the purpose of establishing an overriding bureaucracy that will extend into every State and city, but for the purpose of establishing clearly the Federal authority and responsibility over (1) interstate waters (which may now be the case), (2) navigable streams and their tributaries, and (3) underground water reservoirs in such manner as to permit the Federal authority to prescribe general levels of research, education and training, intelligence, enforcement, and financial assistance. Water resources facilities are too scarce, water-trained personnel and technicians are too few, and water intelligence is too limited to permit their indiscriminate use or waste. Fifty different States going off in all directions will not produce 50 good answers to the problems of water quantity and quality. Add to this confusion the uncoordinated activities of several thousand cities, industries, and other water users and polluters, and you will have confusion compounded.

The authority of the Surgeon General was established in 1944 by the Public Health Services Act; was broadened in the Water Pollution Control Act of 1948 which was extended by the 82d Congress in 1951 and reaffirmed by the Water Pollution Control Act of 1952; and was strengthened by the Water Pollution Control Act of 1956. The legislation should be brought up to date and the authority of the Surgeon General established clearly over all water resources insofar as pollution control and allied functions are concerned. Control of pollution in ground water reservoirs is of particular importance. The field is comparatively new. The quantity of water available, the rapidly increasing rate of withdrawal, and the difficulties of detection and abatement of pollution all combine to make it desirable that there be no question concerning the exercise of the full authority of the Surgeon General.

Great progress has been made during the past few years. So-called model water control legislation has been developed by the Public Health Service and has been made available to the State legislatures. Some States have adopted the legislation which should be updated in the light of experience and adopted by all States.

Specifically, Congress should enact legislation to establish the river basin as the basic unit for development of water resources and within that framework: (1) to provide for comprehensive development of resources for maximum-use, multiple-purpose works; (2) to provide for recognition of all purposes in water projects, including navigation, flood control, power, water supply, irrigation, recreation, conservation, and pollution control; (3) to provide for appraisal of present and future benefits on a uniform basis applicable alike to all projects in similar circumstances; (4) to provide for municipal, State, and

Federal participation in costs on a uniform basis applicable alike to all projects in similar circumstances; (5) to provide for Federal assistance for research, training, and water intelligence purposes subject to such coordination at the State levels as may be prescribed by the Public Health Service; (6) to provide for pollution control on all waters intrastate and interstate in accordance with a program to be prescribed by the Public Health Service; (7) to provide for the development of appropriate water management legislation, including such present and continuing levels of pollution control as may be prescribed by the Surgeon General, to be adopted by State legislatures as a condition precedent to Federal assistance of any kind in water projects; and (8) to provide for levels of coordination between municipalities and the various State boards of health, on the one hand, and between the Public Health Service and State boards of health, on the other hand.

State legislatures should adopt legislation authorizing States and cities to participate in river basin projects and within that framework: (1) to provide for cost sharing by municipal and State governments of appropriate portions of present and future benefits of maximum use-multiple purpose works; (2) to provide for coordination of intrastate research, training, and intelligence at State levels, presumably with State boards of health or water pollution control boards; (3) to provide for pollution control on all waters in a manner supplementing river basin programs established by the Federal Government; and (4) to provide for development of appropriate water management ordinances with respect to environmental sanitation, sewer use, and levels of pollution control, all on a present and continuing basis, such ordinances to be adopted and placed in effect by the municipality as a condition precedent to receipt of Federal or State assistance and approval of State permits for municipal sewage discharges and sewer line extensions.

Municipalities should adopt ordinances to supplement Federal and State legislation and within that framework: (1) to provide for pollution controls at the local level applicable without exception to all pollution originating in or flowing through municipal limits; (2) to provide appropriate regulations governing sewer use; (3) to provide appropriate regulations governing environmental sanitation; (4) to prove appropriate regulations governing use of industrial sewers; (5) to provide appropriate standards for operation of municipal sewage treatment works; and (6) to provide appropriate standards of in-plant pretreatment of industrial waste before acceptance in municipal sewage systems.

### Enforcement

With respect to the enforcement of pollution controls, it is clear that municipal authority is confined to city limits and that State authority ends at State boundaries. Federal authority must be used to control interstate pollution and that authority should be definite and conclusive and applicable either upon the authority of the Surgeon General or the request of any State or municipality aggrieved by pollution.

This is not to say that Federal authority should not be used on intrastate pollution matters. It is to say that primary enforcement activities should be left to the States and the municipalities without bureaucratic duplication at the Federal level. The level of enforcement should be prescribed by the Surgeon General, and Federal authority should be made available when States or municipalities are unwilling or unable to act effectively.

Unfortunately, it is unrealistic to expect a municipality to adopt complete pollution controls unless and until basinwide action is taken by all the cities involved. The political facts of life being what they are, an FBI level of pollution control enforcement can no more be accomplished by the municipality solely than a city can maintain an FBI level of general law enforcement. However, the combination of local enforcement efforts reinforced by State authority and buttressed by Federal authority can be most effective.

### Financial Assistance

Considering all the aspects of Federal assistance and cooperation, the greatest immediate need and direct benefit may be related to financial assistance. Certainly the need is staggering.

The only time when construction of sewage treatment facilities kept up with sewer construction in this country was during the Federal public works programs of the 1930's. Before that time, and since, the number of persons served by sewers increased much more rapidly than the number served by sewage treatment facilities. The construction of industrial waste treatment facilities has never kept up with the increase in the number of industrial sewer outlets or the increase in the industrial waste. As a result, a large backlog of necessary sewage and industrial treatment construction has accumulated through the years.

Nearly 2,900 new sewage treatment works are needed to serve 19.5 million persons living in communities that have never provided treatment for their waste. Another 1,100 new plants are needed for 3.4 million persons in communities where treatment works built in the past have become overloaded or obsolete. In addition to these 4,000 communities needing new plants, another 1,600 communities have sewage treatment facilities requiring enlargement or the addition of new units or processes in order to serve adequately populations totaling more than 25 million.

This backlog is not the whole problem. Population growth and urbanization create new sewage treatment needs continuously and existing treatment works become obsolete. If municipalities are to catch up with the treatment needs by 1965, they will have to spend \$1.9 billion to eliminate the backlog, \$1.8 to provide for new population growth, and \$900 million to replace plants which will become obsolete. Insofar as industrial waste is concerned, it appears that some 6,000 construction projects are needed at a cost of another \$4.5 billion.

Most cities are creatures of their State legislatures and, except for the comparative few that have been granted some measure of home rule, are operating under debt limits and terms dictated by their State. Most municipalities already are staggering under debt limits that are as high as they can go. As a general rule, property taxes, or ad valorem taxes, have reached a point beyond which further property taxes would mean confiscation. The other great reservoir of taxes, the income tax, is preempted for the most part by the Federal Government.

Shifting the burden of financing local pollution control works from the city to the State to the Federal Government is not the answer. Each level of government—Federal, State, and local—should bear its share within the framework of a river basin program. Generally, municipal sewage works are financed by general obligation bonds with 10- to 20-year maturities. This is unrealistic in view of the nature of the works, the pressing need for financing large-scale programs, and the longer maturities of other types of municipal obligations. If the State of California can sell 100-year maturity water bonds for its Central Valley Project, why should bonds for sewage and treatment works which are an integral part of any water supply program have maturities greatly less than the life of the projects?

A better solution may be the use of revenue bonds for financing the municipal share of cost of constructing water and sewage works. Certainly it would have the advantage of being outside the property and income tax fields, and the users of the service would pay the bills. Taxpayers and water and sewer users may not be the same persons, and if not the freeloaders are imposing a heavy burden on the taxpayers. Few bonds other than general obligation bonds enjoy the certainty of payment that is present in water and sewer revenue bonds, and this fact is reflected in the favorable interest rates. Maturities should be extended to a minimum of 50 years, with provision for additions for modernization purposes.

Long-term revenue bonds of our cities for water development and water quality pollution control purposes should be immediately marketable under a Federal system of guarantees such as FHA-guaranteed mortgages or guaranteed loans for defense production purposes. In addition, a Federal finance agency similar to a "WATER RFC" ("Water Resources Finance Corporation") should be authorized to discount, purchase, or collateralize such bonds for loan purposes. Federal grants-in-aid and Federal assistance in financing should be accomplished on the river basin basis if possible and with each State bearing its proportionate share of the cost of each project as it relates to an overall river basin water development and control program.

In any event, this cardinal rule should apply to all Federal financing whether by loan, grant, subsidy, or other means. No Federal money should enable any project to continue water pollution practices. The adoption of water management and quality controls on a present and continuing basis should be a condition precedent to the application for Federal funds, and this requirement should be applied to public works projects also.

The construction of individual water and sewage treatment facilities by each individual city is absurd. Especially is this so when cities are crowded together and are dumping waste into a common supply source. Pipelines are simple to construct and easy to operate. Wherever possible, consolidation of public water and sewage works should be made both intrastate and interstate. The economics of costs, shortage of competent personnel, increased efficiency of operation, and improved health results indicate the advisability of consolidated works.

Industrial sewage operations are of a great variety both in method and efficiency. Public health responsibilities should not be abandoned or delegated by the municipality and, where at all possible, industrial sewage should be discharged into municipal works. Neither should municipalities evade their responsibilities of public health to their citizens either by the deannexation of trouble areas and industrial pollution sources or by failure to annex and to bring such problems under municipal control. The pollution will not disappear simply because local officials lack the courage to deal with powerful industrial interests not primarily concerned with the public welfare.

## Research

The national water pollution problem is a complex one involving many facets. Water is withdrawn for use over and over again for many purposes as it flows to the sea. Most of this water is taken for granted and is used freely for all purposes, including the disposal of waste materials. Because of this indiscriminate use, water is becoming badly polluted. The expanding need for water emphasizes the necessity of preserving its quality as our water demand rapidly approaches a final limit of supply.

Water supply and pollution trends show that one of the most pressing problems in water quality management is the need to develop new treatment processes which will remove more of the contamination from municipal waste than we are able to do by present methods which remove only 75 to 90 percent each of the suspended solids and biochemical oxygen demand in domestic sewage. Little of the total nitrogen and phosphorus is removed, and their availability for stream fertilization and algae growth is actually increased. Because of these deficiencies in present treatment methods, large quantities of water must be available to dilute and transport the residual waste after treatment, and when this water is not available serious pollution problems result.

Unless new methods of treatment are discovered, the volume, strength, and complexity of future municipal waste can only result in the discharge of larger and larger amounts of impurities into badly needed water resources. To do this we must develop new treatment processes probably based on entirely new concepts and principles that will achieve what approaches conversion of waste waters to fresh water. This will require a major coordinated research program which must utilize the best minds in the country and be able to attract physicists physical chemists, hydrologists, economists, and devotees of other skills that have not up to now been fully utilized in water pollution research.

Water pollution substances may be classified according to eight general categories: (1) sewage and other oxygen demanding wastes; (2) infectious agents such as disease-causing organisms from wastes of municipalities, hospitals, slaughtering plants, stockyards, and similar operations; (3) plant nutrients of which nitrogen and phosphorus are the two elements principally involved; (4) organic chemical exotics such as detergents, insecticides, pesticides, herbicides, petroleum derivatives, and decomposition products; (5) other mineral and chemical substances such as chlorides, salts, brine, and acids; (6) sediments consisting largely of suspended solids from the surface runoff into our streams and rivers approximating at least 700 times the loading caused by sewage discharges; (7) radioactive material from nuclear operations; and (8) heat resulting from the tremendous quantities of water withdrawn daily for cooling purposes by steam electric powerplants, steel mills, petroleum refineries, and other similar industrial plants.

It is clear that the Federal level must handle research with respect to the exotic materials or that portion of the research activity charged with pushing back the frontiers. In order to avoid the expense of duplicate effort, the Federal level should be free from routine research operations. Certainly the excessive cost of the more sophisticated equipment such as specialized instruments for the detection of radioactive wastes cannot be duplicated at the municipal level or even at the State level. Until recently, scientific water pollution research averaged less than $1 million a year from all sources. Even now research expenditures total less than $6 million, of which the Federal Government spends $2.5 million, industry $2 million, and the remaining $1.5 million is provided by State governments including university expenditures. This is an exceedingly small sum when compared to the great backlog of unsolved problems and the rapid increase of new problems resulting from new technologies and changing living standards and patterns. This amount should be increased.

In order to avoid the duplication of facilities and manpower engaged in research activities, general levels of research should be established by the Federal Government, and coordinated levels should be assigned to municipalities and States. It is obvious that the sophisticated level must remain within the purview of the Federal agencies. It is also obvious that the municipalities should maintain laboratories for purposes of operating control and for certain basic research work in river basin areas. It is further obvious that a great deal of municipal research can be coordinated at a State level or river basin level. This coordination is desirable in order to avoid clogging the Federal laboratories with more or less routine matters.

In addition to the governmental research programs, it appears desirable to coordinate industrial research if for no other reason than to again avoid duplication of resources and personnel. Municipalities, States, and the Federal Government are presently controlling industrial research indirectly through various ordinances and legislation prohibiting certain results in sewage treatment works. This activity should be increased as the exotic new chemical products continue to pour into public sewage systems. It may be that certain legislative restrictions should be applied prohibiting end use or results. Certainly we are rapidly approaching the time when sewage treatment systems should not be expected or required to accommodate every type of waste that might be dumped into it as a result of industrial processes. It may be necessary to explore the possibility of requiring all waste to be within certain limits of tolerance, the net results of which requirement would be that industrial research would be centered specifically in the direction of accomplishing in-plant waste treatment methods before new products were permitted to be dumped into public sewer systems.

### Intelligence

Successful management of water resources requires adequate information. Both the collection of data and the application of research to the solution of water pollution problems need to be expanded greatly. Basic data for pollution control consists principally of information on the source, kinds, and amounts of pollution; the causes of pollution and its effects on water quality and uses; the present and future intended uses of water; the pollution prevention and control measures required to accommodate the planned water uses; the kinds, costs, and efficiencies of remedial treatment works; and the costs and benefits associated with pollution and its control.

These data need to be collected, evaluated, and distributed on a cooperative basis among the water resources agencies concerned. To make the data more reliable, they need to be collected on a continuing basis in all the river basins; to make them more usable, they need to be made available on a continuing basis. We need to know where and why we are gaining or losing ground in the control of pollution. We need to maintain a water intelligence that will detect pollution situations as they arise before they become major problems. We need this surveillance and intelligence both on interstate and intrastate waters.

The Public Health Service has established a basic data collection program the most recent phase of which was started in 1957. This is the national water quality network which is now operating 62 stations on interstate streams in a proposed network of 250 to 300 stations considered necessary to provide minimum interstate water quality service. The network is currently being expanded to 75 stations and an increase to 120 stations is being planned for 1961. This water quality network should be expanded and should be applied on a mandatory basis to all municipalities with a sewage disposal load equivalent to a population of 5,000 people.

The basic data program as a whole requires complete cooperation between municipal, State, and Federal agencies. The importance of the program is such as to warrant it being applied by legislation on a mandatory basis rather than on the basis of cooperation. Municipal information needs to be coordinated at the State or regional levels in order that river basins may be handled as separate units, and further, in order that a great mass of routine information not clog the administrative channels in Washington. Such legislation as may be adopted with respect to the mandatory collection of basic data should be applied without exception to all industrial operations discharging waste into rivers and streams outside municipal or metropolitan sewage disposal works.

Much can be accomplished once we know precisely the nature and extent of the problem. A number of States have basic water quality data collection programs underway at the present time. All States should adopt this program for the obvious reason that river basin programs can become effective only as all the information becomes available.

### Education and Training

Unfortunately, we are not operating our present sewage disposal facilities at the top level of their capabilities because municipalities refuse to recognize the technical requirements and skills required. Personnel involved in such activities should be placed within a professional category in municipal job rating scales and should be removed entirely from political appointment or even tenure programs not based directly on technical competance.

Two types of training generally are available in this field. First, the so-called in-plant training which should be a requirement of all municipal sewage treatment works and particularly those works benefiting from Federal aid. A condition precedent to Federal aid should be established wherein adequate in-plant training programs are carried out on a current and continuing basis. Second, academic training is available largely through universities and colleges. While this training itself is desirable, the means and resources are quite limited in comparison with the number of technicians that will be needed within the next 15 years for pollution control purposes.

Here again we find a field in which duplication of effort and overlapping activities should be subordinated to Federal coordination establishing training levels for the municipal, State, and Federal Governments. The so-called exotic fields should be handled by the Federal Government for the country as a whole. The coordination of various State or regional activities should be delegated to the States through their boards of health and State universities, supplemented by a program of licensing on an annual basis within each State certain categories of operators employed in pollution control works. Basic training can be accomplished at the municipal level and it can be supplemented with annual schools both in the State universities or conducted for licensing purposes by the professional organizations involved. Training and technical skill of pollution control operators should be as much a prerequisite of employment as the professional training and skill of any other professional employee.

### Public Information

A major hindrance to the accomplishment of an effective water quality program is the apparent reluctance of the public to finance such programs for pollution control. Much of this reluctance may be attributed to the lack of identification between taxes and the pollution control functions provided by government. Related to all the elements in water quality management is the need for a much better public understanding of the water pollution situation and greater public support for what needs to be done.

We need to remove public consideration of water as a cheap commodity. We need to relate in the public mind the cost of water to the cost of pollution and let the economics of the situation, presently estimated at $1 billion annually, apply to each local community. We need to inform the people in our cities of the huge investment now accumulating in water and sewage treatment plants and to make them aware of the false savings accomplished by irresponsible public officials in reducing maintenance on these multibillion dollar investments.

We need to inform the public in our cities that water and sewer service are the two most valuable services performed by a municipality, and that they should not be made available beyond municipal limits except under most extreme circumstances. Our people need to know the direct relation between irrigation use, municipal and industrial use, and conservation and recreation in order that they may realize water must be kept clean for all these purposes. We need to inform our people of the dangers faced by a community both for health and economic reasons in those situations wherein large industries refuse to adopt pollution control measures and threaten withdrawal from the city if controls are forced upon them. Certainly no industry, regardless of its size, is more important to a community than the health of all the citizens in the community, and certainly no single city is more important to a river basin area than all cities combined in the same area.

We need to inform our people of the grave dangers, the serious difficulties of detection, and the technical problems of abating water pollution in underground water sources. Unfortunately, pollution in these underground water reservoirs is not as readily apparent as it is in surface waterways. Once present, pollution may work its way through an entire ground water reservoir and not become apparent until many years in the future. The increasing importance of ground water reservoirs as a source of supply indicates the advisability of complete public information and knowledge of this important aspect of our national water problem.

We need to establish an annual rating procedure applicable to water supply and pollution control works in each municipality in much the same manner as the annual rating of the fire department, by the insurance underwriters. Efficiency of operations can and should be measured and the results should be made known to an informed public at least on an annual basis.

In addition to the critical nature of the water supply problem and in addition to the fact that the quickest way to alleviate our present water shortage is to clean up the water we already have available, it should be made known to our people that river basin developments require the complete cooperation of all cities and States in the river basin area. It must be made clear that no single community can clean up a polluted river basin area by itself and conversely that a river basin area cannot be cleaned up as long as any one single city persists in pollution practices.

Unfortunately, local officials elected by their municipal citizens are frequently unwilling or unable to relate conditions within their own city to an over-all river basin operation. The cooperation of cities should not be left to chance but should be required as a part of legislation applicable to all cities alike under similar circumstances throughout the river basin area. Federal aid, whether in the form of grants or otherwise, should be made available to those municipalities seeking to improve their pollution situation. Federal aid should be reserved for those municipalities willing to cooperate within a river basin program. Federal aid should not be made available to municipalities on the basis of placing a premium on recalcitrance. Those cities which deliberately permit themselves to be branded as polluters and deliberately refuse to build sewage treatment works in order to attract Federal aid for remedial works should not be encouraged in that direction.

In conclusion, it is clear that we should be shaping a broad national water policy with the river basin as the unit for development and administration. Water resources policy and water quality management are so inter-related as to make it impossible to discuss one without the other. We should adopt stringent pollution measures now at the city, State and Federal level and we should develop these controls further in the light of experience and new situations. This will require more action than we have had, more reason than we have shown and considerably more understanding and courage than we have used so far in attacking the problem.

We must protect and improve the water we have and we must find more water. That is the price of survival! (*1*)

## BIBLIOGRAPHY

(*1*) *Land, Wood and Water* by the Honorable Robert S. Kerr, Senator from Oklahoma, published in 1960 by the Fleet Publishing Company.

(*2*) United States Senate Select Committee on National Water Resources
  Committee Print No. 2—Reviews of National Water Resources During the Past Fifty Years
  Committee Print No. 3—National Water Resources and Problems
  Committee Print No. 4—Surface Water Resources of the United States
  Committee Print No. 5—Population Projections and Economic Assumptions
  Committee Print No. 7—Future Water Requirements for Municipal Use
  Committee Print No. 8—Future Water Requirements of Principal Water Using Industries
  Committee Print No. 9—Pollution Abatement
  Committee Print No. 12—Land and Water Potentials and Future Requirements for Water
  Committee Print No. 24—Water Quality Management
  Committee Print No. 27—Application and Effects of Nuclear Energy
  Committee Print No. 28—Water Resources Research Needs
  Committee Print No. 29—Water Requirements for Pollution Abatement

(*3*) Remarks of the Honorable Mike Mansfield, United States Senator from Montana as published in the Tuesday 27 January 1959 issue of the *Congressional Record.*

(*4*) Address of Elmer B. Staats, Deputy Director of the Bureau of the Budget, before a joint meeting of Inter-Agency River Basin Committees on Friday 19 August 1960 at the University of Colorado.

(*5*) Statement of the Municipal Conference of Mayors concerning public water supply problems and recommendations as presented by Justus H. Fugate, Mayor of Wichita and A. E. Howse, former mayor of Wichita on 18 November 1959 to the Select Committee on National Water Resources of the United States Senate in public hearings at Topeka.

(*6*) Recommended water and pollution abatement policy submitted by Justus H. Fugate, Mayor of Wichita in November 1959 to the Committee on Water Resources of the American Municipal Association in Denver.

(*7*) Task Force Report on Natural Resources dated January 1949 and prepared by the Commission on Organization of the Executive Branch of the Government. (First Hoover Commission)

(*8*) Task Force Report on Water Resources and Power dated June 1955 and prepared by the Commission on Organization of the Executive Branch of the Government. (Second Hoover Commission)

(*9*) Report of the Presidential Advisory Committee on Water Resources Policy dated 17 January 1956 and prepared by the Cabinet Committee on Water Resources Policy. (House Document 315)

(*10*) A Water Policy for the American People dated 11 December 1950 and prepared by the President's Water Resources Policy Commission.

(*11*) Land and Water—a report dated 1953 and prepared by the Missouri Basin Survey Commission.

(*12*) The Arkansas River and Its Tributaries—a report dated 24 August 1935 and prepared by the Secretary of War pursuant to the Flood Control Act of 31 May 1924, the River and Harbor Act of 21 January 1927 and the Flood Control Act of 15 May 1928. (House Document 308)

(*13*) A plan for Development of Water and Land Resources of the Arkansas-White-Red River Basins dated 17 January 1957 prepared by the Arkansas-White-Red River Basins Inter-Agency Committee. (Senate Document 13)

(*14*) Long Range Water Resources Report dated March 1955 and prepared by the Mayors Advisory Committee on Water Resources.

# The Needs and Obligations of Metropolitan Agencies—County

M. James Gleason

***Multnomah County Commissioner, Portland, Oreg.***

The fine paper by Justus Fugate is very complete and commendable. There are no basic differences in his thinking and my own.

Mr. Fugate has presented a most comprehensive discussion of complete water control, for all puposes—power, navigation, irrigation, timber—palatable and polluted. He has embraced methods of proper water management.

These problems are problems of very grave concern to us from the Far West. However, for purposes of this discussion, I will confine my remarks to water pollution as it affects counties and cities making up metropolitan centers.

So that we may all understand the terms used by Mr. Fugate in relation to my own usage, let us consider them briefly. He uses the terms municipal, municipalities and municipal limits. Many times they are misunderstood. Popular understanding is that they refer to cities. I have discussed with Mr. Fugate his meaning of the term municipal and find that he encompasses any form of local government less than a State—that is, cities, towns, counties, metropolitan areas, etc.

However, as I use the terms counties, cities, districts and metropolitan area in my remarks I will be referring to the same areas as did Mr. Fugate when he used municipal, etc. Use of these subordinate terms will clarify my thinking by identifying a particular segment or unit.

For many years it was considered that sewers ended at city limits. But new thinking came in the last three decades, 1930–1960, as experience showed that population was moving into counties *outside* incorporated cities—thus forming large metropolitan areas.

People and industries locating in these metropolitan areas regard the central city as the business and cultural center of their lives and operations. But they make their homes in the suburban districts.

Two-thirds (66⅔ percent) of the Nation's growth in the past decade (1950–1960) has been in these metropolitan areas *outside* the central city. In the United States there are at the present time, 54 million persons living outside the central city in the metropolitan areas. Another 57 million are living inside the city in the metropolitan areas. With the continued expansion of growth outside of the central city, there is an urgency for services for which the population is willing to pay, and which it needs. Definitely there seems to be no inclination by these 54 million people to annex themselves to the central city. Frankly, there isn't need to join the central city. There are other competent governmental structures which can provide services as needed and should provide them *wherever* the population is located.

Because of rapid urbanization, county government has had to change its thinking. It has moved from problems of a basically rural nature to an urban structure of services in all of these rapidly growing areas. This has come from the need to provide facilities such as streets water, schools, water distribution and sewers and treatment plants.

Counties are in a most enviable position to provide leadership in these fields. They are best able to be the coordinator among cities, districts, towns and for other counties because they are the larger of local governments. In reality, they already are coordinating many unified services, such as collecting taxes for the other levying bodies within the county.

In control of water pollution all local governmental units must work together for a unified system. Only a unified system can bring fair and equitable rates that will provide for construction, maintenance and expansion. Only such unification will properly serve the population and the industries of the metropolitan area. Rates should be uniform for the entire area, so that no individual or no one industry will have a trade advantage in its home market.

The methods of financing public projects often have confused the average citizen. He has mistakenly believed that the total cost was to be the amount of the general obligation bonds issued. But he has overlooked, or not been thoroughly acquainted with all the financing costs—interest, legal fees, etc. There is no bargain basement price on good pollution control.

There is another evil. Too much of the thinking on Federal grants to communities has been on small unconnected plants that were uneconomical, could not provide for expansion of population or have a large enough unit to provide for proper maintenance and operation.

Often the result has been a continuation of the local pollution problem.

Let us look at our situation today:

(1) In a report by Abel Wolman, in 1953, he said, "It required nearly one-third of a century to eliminate cesspools and septic tanks in a large part of the congested area of the United States. Today we find that accomplishment has become negative. In the last 12 years we have put in more septic tanks and cesspools than we took out in the previous forty. We describe this situation as one that 'crept up on us'." This was from 1941 to 1953 and the situation is twice as bad in 1960.

(2) Population in central cities and metropolitan areas are nearly equal—57 million in the city—54 million outside. The population outside the central city is growing almost six times as rapidly as it is inside the city. Within a very few years many millions more of the population will reside outside the central city than in it.

(3) Right now—today—there is an urgent demand and need for service for most of the 54 million who already live outside the central city.

(4) Right now there is an ever-present danger of disease as well as a lowering of the standard of living for all unless service is provided.

(5) When the need for service is properly presented, the public is willing to pay.

(6) It is unrealistic to contemplate the withholding of needed services to force annexation to central cities.

With the above facts in mind, let us examine our position and set a course that will provide the needed protection to society and give it at a cost compatible with the benefits.

As I see it, there are two alternative courses from which to choose. The first would superimpose another governmental unit (Metro) with its attendant costs and bureaucracy. The second would use the existing governmental units, cooperating on jobs too large for a single unit and without regard to arbitrary political boundaries.

I choose the second course. It is far superior. I believe that reasonable, efficient officials can cooperate and submerge local pride, that they will subordinate local feeling to a much-needed and better solution of problems in the larger area.

The counties, because they are the larger unit and are not so narrow in their boundaries, are ideally suited to be the coordinating party for projects that are larger in scope than cities but smaller than of river-basin in size.

In projects smaller than river-basin areas you have to think in watershed or drainage-area scope. A drainage area may encompass one or more counties, many cities and districts. A metropolitan area may possibly encompass more than one drainage area. The entire metropolitan area needs to be serviced by a unified system. The project needs to be engineered as one system, planned as one system, with rates designed for one system and managed as one system. Plants, interceptors, trunks and laterals should be designed and built for the maximum population forecast for the area. The most economical system is by gravity flow and should be handled and treated by the governmental unit best situated, regardless of what political boundaries are crossed.

Much legislation is needed on both Federal and State levels to make this possible. Federal legislation will be needed to provide:

(1) Pollution control standards by U.S. Public Health Service.

(2) Combination of grants allocated to individual plants into a larger, more comprehensive program. Each allocation allowable for small plants and interceptors should be added together for a larger metropolitan plant and interceptor system.

(3) Establishment of a National Investment Fund to provide long-term financing for prudent and necessary public works. This should be at reasonable interest rates, possibly with interest for the first few years waived and payment deferred until the system is built and operating.

Now for the State Legislatures—what must they do? Legislation is needed to—

(1) Allow cities, counties and individuals to contract for design, transportation and treatment of sewage.

(2) Allow master plans for sewage disposal in metropolitan areas, with enforcement that will prevent sub-standard construction in any section of the master system.

(3) Empower the State Public Health or State Sanitary Authority to enforce proper design, treatment and transportation of sewage.

(4) Allow long range general obligation and revenue bond financing if desired.

(5) Have State Public Health or State Sanitary Authority inspection and enforcement of level of treatment, including infiltration of surface water.

To accomplish this it is essential to have the highest type of local leadership. This requires:

(1) An awareness by public officials—city, county, district, etc., of the need for this type operation and the savings that a metropolitan unit will bring.

(2) An awareness of these needs and the desirability of the plan by all public information sources—newspapers, T.V., radio, medical societies, service clubs, etc.

(3) Complete agreement by both public and officials as to—
  A. The need.
  B. The benefits.

(4) Cooperative contracts between the affected public bodies covering cost, scope of services, charges, and all other basic elements.

(5) Single engineering studies, design and construction.

In the matter of financing there are five possible courses. They are—

(1) General obligation bonds.
(2) Revenue bonds.
(3) Connection charges.
(4) Tax Levy.
(5) Monthly charges.

All of these may be used or any combination used. But it is important that whatever method of financing is chosen it should be engineered for sufficiency and fairness.

At this point, in my discussion, I should like to present an outline of the areawide plan that I instituted in the Portland Metropolitan Area.

## A Review of the Tri-County Sanitary Authority of Multnomah, Washington and Clackamas Counties of Oregon

In the fall of 1954, with a spiraling metropolitan population, Commissioners of Multnomah, Washington and Clackamas counties faced an increasingly critical problem brought on by untreated sewage, recognized that the sewage problem did not follow political boundaries nor was it confined within any one unit.

The initial steps involved meetings with the health officials and governing bodies of the three counties and the engineering staff of the Oregon State Sanitary Authority. These officials and engineers were fully aware of the situation and were just as eager as I to institute positive action toward the solution of this problem. It was from these meetings that the "Tri-County Authority" was formed.

The metropolitan and urban area covered by this Tri-County Authority involves an area of 150 square miles, lying east and west of the Willamette River which flows northerly to the Columbia River. In the area are ten incorporated cities in three counties. The Willamette River also flows through the city of Portland.

In general, the city of Portland area on the west side of the Willamette River is high ground with steep slopes, thus preventing the flow of sewage from unincorporated fringe areas to the city of Portland's sewerage system. Likewise, several areas of the city of Portland lying west of this high ground presently require pumping sewage over the hills to the city's system.

Fortunately for the Tri-County area and the city of Portland, the Willamette River can successfully accept secondary treated effluent, which is a requirement of the Oregon State Sanitary Authority, and the Master Plan envisions such a system with complete gravity flow.

It was first necessary to predict the population to determine the size of the facilities needed. The population trends very clearly indicate why numerous problems exist in the suburban areas. The present metropolitan population is 647,000 of which the population in the area that Tri-County would serve is 276,000. From 1930 to 1960, outside the Portland corporate limits, the population increased 350 percent while for the same period inside the city, it only increased 23 percent. However, it is interesting that the population of the city has shown a slight decrease in the last 10-year period.

Determination of the design population was an important part of the work involved in this study. Every possible source of information, including local planning commissions, census reports, school, water and fire districts and work by the League of Oregon Cities was utilized in determining the population densities to be considered. Generally the area was divided into four population classifications, less than three per acre, 3 to 5 per acre, 5 to 10 per acre and 10 to 15 per acre. All population extensions were made on a 50-year basis or to the year 2005. On this basis the design population was determined to be 587,000, exclusive of the city of Portland.

This committee then sponsored certain bills in the 1955 session of the Oregon State Legislature. They included:

(1) Adoption of a coordinated Master Plan for the collection, transportation and treatment of sewage.

(2) Requirement that the plans for the installation of new sewer systems or sewage treatment works in areas under Tri-County jurisdiction outside the boundaries of cities conform to this Master Plan.

(3) Legislation for conduct of surveys and investigations, levy and collection of taxes for the purpose of providing funds to prepare the coordinated Master Plan, expenditure of funds for such surveys, investigations and studies. Also, allowed the authority to enter into contracts or agreements with cities, other counties, the Federal Government or any other person for the cooperative financing and developing of a coordinated Master Plan.

With the enactment of this enabling legislation, the Tri-County Authority retained the services of a consulting engineering firm to prepare a Master Plan for the metropolitan areas of the three counties.

In addition to the population trend this Tri-County Master Plan was extremely comprehensive including geography and topography of the Tri-County area, existing subsurface disposal and sewerage systems, suggested revisions to the sanitary statutes of the State, treatment plant location and costs; and, interceptor and trunk locations, size and costs.

I recognized that the planning of sewerage works upon a basin-wide area provides the most economical means for the solution to the perplexing environmental sanitation problem in Tri-County. The present multiplicity of municipal entities within the Tri-County area serves to complicate the problem and a satisfactory solution cannot be realized by following the unit development plan of the past which must by necessity yield to an accepted over-all coordinated system.

Most of the local streams can be regarded only as temporary channels for final disposal of treated sewage. Most of these streams would be dry in the summer except for effluents from sewage treatment plants. These streams are in no way capable of accepting treated sewage without causing a measurable degree of pollution and resulting nuisance since from 10 to 20 percent of the pollution material of sewage is not removed prior to final disposal in the average secondary treatment plant.

The cost of the small sewage treatment plant is high, being $50 and $60 per capita; whereas a large plant serving 100,000 or more people could be constructed for a cost close to $30 per capita. Since the small sewage treatment plants in Tri-County must eventually be abandoned, an economic waste exists and the economic loss can only be held down by use of temporary plants designed for short service life.

Sewerage systems are always expensive to install. However, experience has shown that the increases in property values usually more than offset the cost of installation of sewerage facilities.

In the development of new tracts this may be explained by the fact that in many areas much smaller lots can be used if a sewer system is installed rather than individual septic tanks and drain fields. This not only accomplishes efficient use of the land by permitting more residences per acre, but also reduces the cost per unit for all improvements. A reduction in lot frontage will effect a direct saving to individual property owner for streets, curbs, walks, storm drains and water lines. Indirect savings will be realized through reduced cost to the utility companies for power, telephone, and gas lines which can be passed on to the consumer. In some areas much needed housing construction has been retarded or completely stopped because of the lack of sewers. Even oversized lots cannot solve the sewage disposal problem where high ground water and impervious subsoil exist.

Resale values of homes are considerably higher in those areas served by a sewer system. Buyers have become increasingly aware of the importance of an adequate and permanent solution to the sewerage problem. A well designed and constructed public sewerage system is the only acceptable answer to many discerning purchasers. In some areas where the soils are clayey and there is a high ground water table the resale of homes is almost nil except to those unacquainted with the sanitary sewage problem. A modern sewerage system will immediately bring the value of these homes up to the normal market prices enjoyed in areas more favorably situated.

Certain areas within the city limits of the city of Portland are within the drainage basins considered as part of Tri-County and the ultimate disposal of sewage from such areas, although within the city limits, should and will be through Tri-County facilities.

Had such a disposal system been constructed, the city of Portland would not have been forced to construct, at no small cost, several major sewage pumping stations to pump sewage over the hills into the city's existing sewerage system, but instead could have used the more logical and economical gravity system of Tri-County.

The basic concept of the Master Plan envisions:

1. A major Tri-County sewage treatment plant on the Willamette River near Oswego with an ultimate capacity suitable to treat the sewage from a population of 587,000.

2. A basinwide system of interceptor and main trunk sewers to serve a population of 309,000 in an area of 65 square miles lying west of the Willamette River.

3. A basinwide system of interceptor and main trunk sewers to serve 278,000 people in an area of 85 square miles lying eastward to the Willamette River.

The estimate of cost for construction, as outlined in the Master Plan, brought up to date is $33 million for plants, interceptors and trunks, and upon completion will be a self-sustaining operation. While there was no estimate of cost for the construction of laterals and house-branch connections in the Master Plan, it is the general consensus of opinion that this cost is in the area of $30 million.

In order to make an actual start on the construction of this system, being governed almost entirely by finances, it was decided to build two interim treatment plants having a capacity of 20,000 persons each. One was to be built on the site of the permanent plant along the Willamette River; the other centrally located in an area where heavy urban development is being experienced. The Tri-County Authority engaged the services of a consulting engineering firm widely experienced in this field to make the design. Both plants are designed for secondary treatment and must provide at least 90 percent efficient B.O.D. (Biological Oxygen Demand).

Consideration was given in the design toward incorporating these plant units in the permanent plant to be constructed at a later date.

The Tri-County System, in addition to the plants, includes only sanitary trunk and interceptor sewers from 12 inches to 60 inches in diameter; all being designed on the basis of the predicted population 50 years hence. The design rate of flow is 130 gallons per capita per day average with 300 gallons per capita per day as maximum. Based on the predicted population and these estimated flows, an average of 40 million gallons per day of sewage from the west side of the Willamette River and 36 million gallons per day from the area east may be expected.

For the present Multnomah County is acting as an agent for the Tri-County Authority and since June 1959, we have spent $1,200,000 for engineering, plant and interceptors. A connecting district has spent another $1,500,000 for a collection system. In addition to this sum we are in a position to receive $250,000 from the Federal Government, Public Law 660—Health, Education, and Welfare, Public Health Service.

One interim sewage disposal plant, capable of serving 20,000 people, has been constructed and will be in operation by January 1, 1961. Also, approximately 1 mile of interceptor sewer ranging from 30 inches to 60 inches in size has been constructed and another 4 miles is planned for next year.

As to financing the over-all project, after considerable investigation, it was determined that utility type financing would be the most desirable. We thought that it was more desirable to collect for the connection to the system from the person at the time of the actual connecting with monthly rates sufficient to provide money for construction, operation, repair, expansion, etc. It is the philosophy of the Tri-County Committee that all users of the system shall pay equally for the "community benefits", i.e., the trunks, interceptor sewers and treatment facilities.

In order to arrive at the rate to be charged for connection to our system a "Comprehensive Rate Study" was prepared. The purpose of this engineering, economic and rate study of the area was to establish the Tri-County standard rates.

Broadly speaking, it was determined that for the average single family dwelling, a fee of $300, to connect was to be collected. Rates were also established for multi-family dwellings, high schools, hospitals, industrial and commercial buildings, etc. A monthly sewer service charge was also determined by the study. (See tables.)

It was decided to use the more or less universal collection of sewer service charges, measured by the domestic water consumption of the user. On the following pages are the tables for both the connection and the sewer service charges.

The most obvious need at present is for construction financing. Without monetary aid the area does not have sufficient valuation to construct sewage facilities and without facilities the area cannot develop. It is believed that the most helpful aid would be in the form of long term loans, probably with interest deferred, until the project develops to a point where it is self-sustaining. Some Federal legislation would most assuredly be of great benefit to the counties in helping toward the solution of the common problem.

## Tri-County Authority, Multnomah County

### Sewer Connection and Service Charges

TABLE I

For the purpose of determining connection charges for various types of establishments:

| | |
|---|---|
| Single-family dwelling | 1 unit per dwelling. |
| Multi-family dwelling | 1 unit per family unit. |
| High Schools | 12.5 students per unit. |
| Elementary Schools | 17 students per unit. |
| Motor Courts | 2 rental spaces per unit. |
| Trailer Parks | 2 rental spaces per unit. |
| Restaurants and Taverns | 6 seating spaces per unit. |
| Hospitals and Institutions | 2.5 beds per unit. |
| Industrial and Commercial Buildings | 10 employees per unit. |
| Domestic "U Wash" Establishments | 3.2 washing machines per unit. |

### Industrial Wastes Equivalent to Normal Sewage

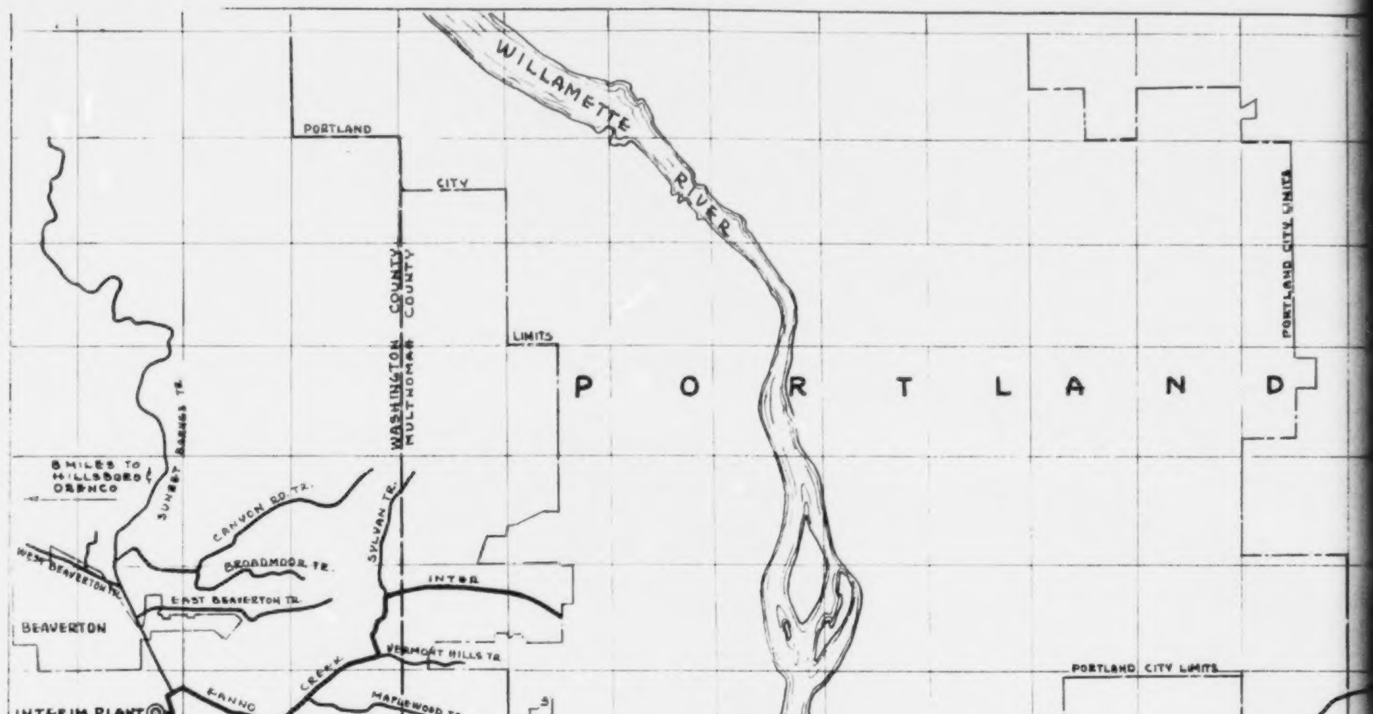
For facilities contributing such wastes to the system, size can best be established by population equivalent based on volume of water consumption. On this basis, each 950 cubic foot increment of water consumption equals one unit. Adjustments must be made for special cases where large volumes of water consumption do not reach the sewer. Where it is determined that any wastes are injurious or harmful to the operation of the sewage treatment facilities then pretreatment will be required.

TABLE II.—*Connection charges for multiple unit facilities*

| *Number of units* | *Total connection charge* |
|---|---|
| 1 | $ 300. |
| 2 | $ 588. |
| 3 | $ 864. |
| 4 | $1,128. |
| 5 | $1,380. |
| 6 | $1,620. |
| 7 | $1,848. |
| 8 | $2,064. |
| 9 | $2,268. |
| 10 | $2,460. |
| Over 10 | $2,460 plus $180 for each unit over 10. |

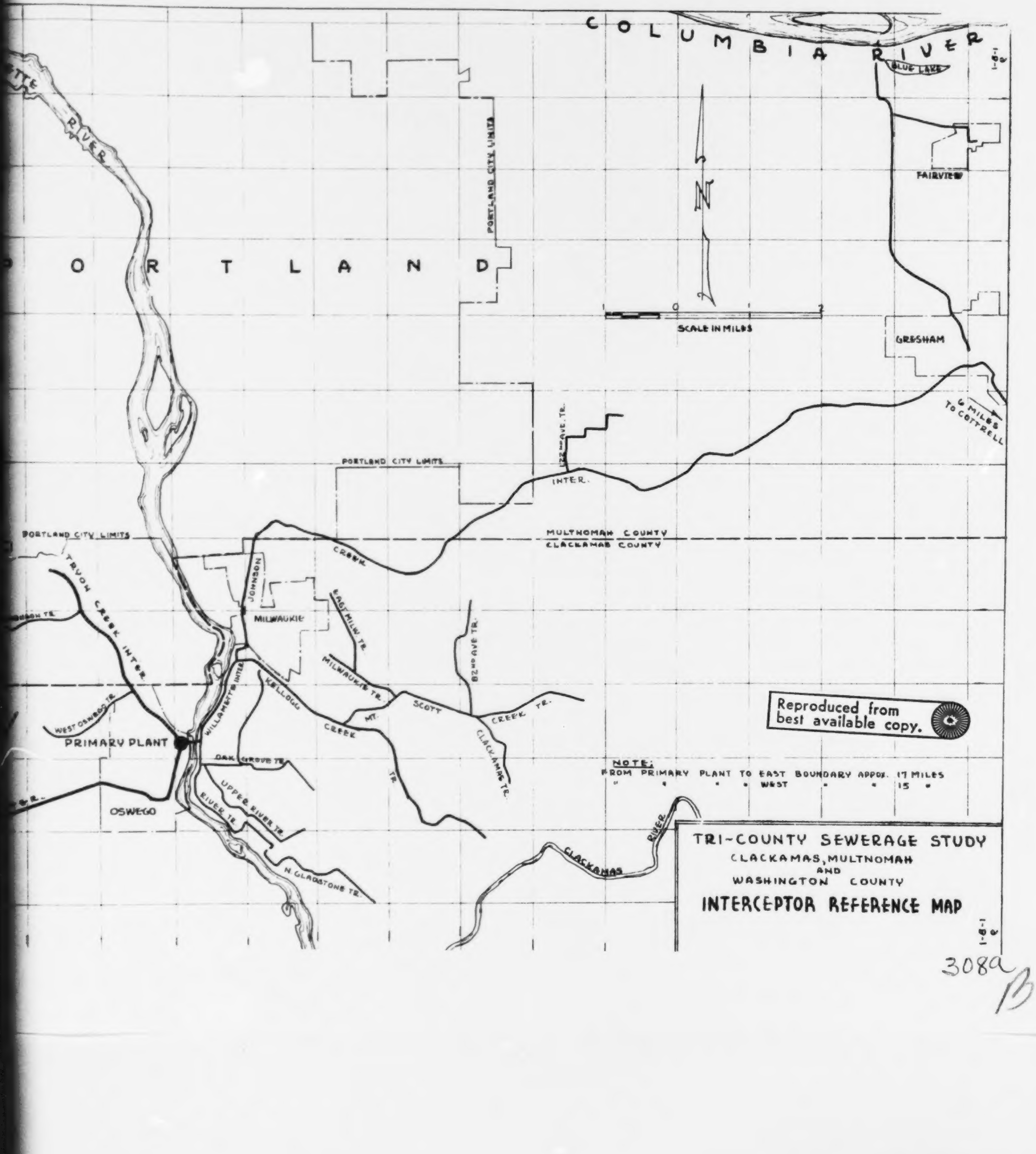
TABLE III.—*Service charges for domestic sewage or equivalent*

| *Total volume of water used (C.F.)* | |
|---|---|
| 0–950 | $2.00/month minimum. |
| 951–1900 | $2.00 plus .0020/C.F. for excess over 950 C.F. |
| 1901–2850 | $3.90 plus .0019/C.F. for excess over 1900 C.F. |
| 2851–3800 | $5.71 plus .0018/C.F. for excess over 2850 C.F. |
| 3801–4750 | $7.42 plus .0017/C.F. for excess over 3800 C.F. |
| 4751–5700 | $9.04 plus .0016/C.F. for excess over 4750 C.F. |
| 5701–6650 | $10.56 plus .0015/C.F. for excess over 5700 C.F. |
| 6651–7600 | $11.99 plus .0014/C.F. for excess over 6650 C.F. |
| 7601–8550 | $13.32 plus .0013/C.F. for excess over 7600 C.F. |
| 8551–9500 | $14.56 plus .0012/C.F. for excess over 8550 C.F. |
| Over 9500 | $15.70 plus .0011/C.F. for excess over 9500 C.F. |


WILLAMETTE RIVER
PORTLAND CITY LIMITS
PORTLAND CITY LIMITS
P O R T L A N D
WASHINGTON COUNTY
MULTNOMAH COUNTY
8 MILES TO HILLSBORO & ORENCO
SUNSET BARNES TR.
CANYON RD. TR.
SYLVAN TR.
BROADMOOR TR.
WEST BEAVERTON TR.
INTER
EAST BEAVERTON TR.
BEAVERTON
VERMONT HILLS TR.
INTERIM PLANT
FANNO CREEK
MAPLEWOOD TR.
PORTLAND CITY LIMITS
PORTLAND CITY LIMITS
CREEK
METZGER TR.
TRYON CREEK INTER
JOHNSON
MILWAUKIE
EAST MILW. TR.
STEPHENSON TR.
FANNO
VILLA RIDGE TR.
82ND AVE TR.
MILWAUKIE TR.
MULTNOMAH COUNTY
CLACKAMAS COUNTY
WILLAMETTE INTER
KELLOGG CREEK
MT. SCOTT CREEK TR.
WEST OSWEGO TR.
TIGARD
PRIMARY PLANT
CREEK
SOUTHWOOD PARK TR.
MT SYLVANIA TR.
LAKE GROVE TR.
OAK GROVE TR.
CLACKAMAS TR.
UPPER RIVER TR.
RIVER TR.
INTER.
OSWEGO
DURHAM
N. GLADSTONE TR.
TUALATIN RIVER
TUALATIN

583283 O - 61 (Face p. 308)

A


COLUMBIA RIVER
BLUE LAKE
FAIRVIEW
PORTLAND
PORTLAND CITY LIMITS
N
0
2
SCALE IN MILES
GRESHAM
6 MILES TO COTTRELL
122nd AVE. TR.
INTER.
PORTLAND CITY LIMITS
MULTNOMAH COUNTY
CLACKAMAS COUNTY
PORTLAND CITY LIMITS
TRYON CREEK INTER
CREEK
JOHNSON
MILWAUKIE
EAST MILW. TR.
MILWAUKIE TR.
82nd AVE TR.
WILLAMETTE INTER
KELLOGG
MT.
SCOTT
CREEK TR.
CREEK
TR.
CLACKAMAS TR.
WEST OSWEGO TR.
PRIMARY PLANT
OAK GROVE TR.
UPPER RIVER TR.
RIVER TR.
OSWEGO
N. GLADSTONE TR.
CLACKAMAS RIVER

**NOTE:**
FROM PRIMARY PLANT TO EAST BOUNDARY APPOX. 17 MILES
" " " " WEST " " 15 "

# TRI-COUNTY SEWERAGE STUDY
CLACKAMAS, MULTNOMAH
AND
WASHINGTON COUNTY

## INTERCEPTOR REFERENCE MAP

Reproduced from
best available copy.

# The Needs and Obligations of Industry

LEONARD E. PASEK,
***Special Assistant to the Chairman***
***Kimberly-Clark Corporation***

Inasmuch as this National Conference is being presented under the auspices of the United States Public Health Service, it is fitting for me first to set my brief remarks within a general framework of reference to the concept of public health.

The safety of public water supplies in the United States is world renowned. No other country has so many supplies with so high a quality. This record was achieved by the construction and use of modern treatment facilities; by the employment of qualified operators; and by an ever-increasing knowledge of the principles of water treatment. Health departments, from those at the local level to the state level to the U.S. Public Health Service, played a prominent part in gaining these milestones in public health. Consulting engineers and city administrators helped shoulder the burden of putting local programs into effect. Today a U.S. citizen can travel anywhere in his country and be assured that the water from the tap will be safe. Persons who have traveled in other countries are particularly aware of and appreciative of our good fortune in having supplies that can be counted on to be safe.

There is a great bulk of industrial water usage that need not measure up to high quality requirements. On the other hand, for those water supplies that must be of high quality for particular purposes in particular industries, the reliance is on modern treatment facilities just as it is in the public water supply field, and with equally remarkable successful results. These requirements for high quality industrial water are different and frequently higher than the requirements for public drinking water. From the standpoint of discharge of waste waters, industrial waste waters unless mixed with sanitary sewage do not normally become contaminated with pathogenic organisms which affect public health.

In general, industry feels confident that there is no cause to worry about a national shortage of water to meet the requirements of an expanding economy over the remaining decades of this century.

As stated by the Geological Survey of the United States Department of the Interior in 1960:

> The United States is in the happy circumstance of being well supplied with water. After nature takes its share of water which falls as precipitation, there is available for man's use about 7,500 gallons of water per day for every citizen in the country. Of this available water, we presently use about 1 gallon out of every 5.
>
> In a national sense, then, the country is not likely to run out of water in any foreseeable future.

This confidence is also based upon achievements that are being made in industrial water conservation, both in regard to efficiency of quantitative usage and in regard to qualitative control. The important thing to remember is that industrial water usage, to a very high degree, is non-consumptive. Abel Wolman Associates, in *A Report Upon Present and Prospective Means for Improved Reuse of Water* to the U.S. Senate Select Committee on National Water Resources, states:

> Only 2 percent of the water used by industry is actually consumed, with the greater portion returned to nature and hence not actually lost.

The tremendous significance of the potentialities of water reuse in industry was brought out by a statement made by Dr. Richard D. Hoak, Senior Fellow, Mellon Institute, Pittsburgh, in a speech on the subject of "Water Conservation and Re-Use Possibilities in Industry":

> It has been predicted that industrial re-use of water is likely to be the most important technological development in the water resource field over the next 10 to 25 years. The present re-use, which approaches 100 percent, may be expected to rise to 400 percent, i.e., one gallon of intake water will be used five times. *This would result in twice the present production of goods without a significant increase in industrial demand for fresh water.* (Emphasis supplied.)

Hudson and Abu-Lughod, in a symposium on "Water For Industry" sponsored by the American Association for the Advancement of Science, in 1953, stated:

> In view of the present-day tendency toward incorporating water-saving equipment in new plants, it is believed possible that the industrial water use may not increase in proportion to industrial production and the future total requirements may be little greater than those of the present. Should it become economically feasible to accelerate the installation of water-saving equipment in existing plants, the total need for industrial water might even be reduced.

And, of course, it is just plain good economic horse sense for industry to be frugal with water since water and its use costs money. In this era of keen commercial competition, no unit of our private enterprise economy can afford to be careless about any cost factor.

It is clear that many of the projections made for increased water usage in future years have not taken increased re-use by industry adequately into account. Gross figures for total present or prospective water use, particularly when compared with the estimated potentially available amounts, must be used with caution. The very large return of used water to natural watercourses make the gross figures of water usage extremely misleading as to what the Nation's volume requirements actually are. In addition, it should be kept in mind that many of our present industrial plants were not originally built with water conservation and water quality control in mind. The new plants that are being built are equipped with modern devices to cope with these problems. Thus, projections of future industrial water demand and future industrial waste loads are erroneous in that they ignore the modernization trend that is taking place in industry.

However, I do not mean to minimize the fact that American industry must have large quantities of water available for use. It has been pointed out that, while 1,000 gallons of water can produce about 10 cents worth of agricultural crops, the same 1,000 gallons of water can make $11.70 worth of manufactured goods. It might also be pointed out that agricultural use of the water consumes 80 percent of it, although the U.S. Department of Agriculture has predicted that increased efficiency in use of irrigation water will reduce the volume required by about 20 percent. This contrasts with the very low percentage of water consumption by industry. In any event, the great value of water to our economy in providing industrial jobs and producing the goods and services needed to maintain our standard of living and our national defense is readily apparent. To a very substantial extent, American industry—and thereby our economy—has been built upon the base of that valuable economic asset—the ability of our great waterways to dilute, assimilate and carry away industrial wastes. The result has been a living standard of widespread abundance and a national defense potential that has delivered the goods during three periods of military conflict.

At least three decades ago, however, industrialists began to exert strong efforts to minimize the necessary workload on these waterways. Since that time, great strides have been made in industry's progress toward solution of industrial wastes problems and toward the financing and constructing of the facilities to implement these solutions. It is obvious that, as population grows and industrialization grows, all parties utilizing the diluting, self-purifying and flushing characteristics of our waterways must make some equitable contribution toward preserving their usability. These working streams are vitally important since the most efficient dissipation of pollution is achieved by the stream itself. The real problem is to limit the waste loads in order to keep within the working ability of the particular stream.

Industry's efforts in the field of conservation of water supplies both in quantity and quality are exerted at the plant level, the company level, and through various industry, technical, and professional organizations. Some of these efforts may be listed in the following generalized fashion:

1. Plant and process design and redesign to decrease the amount of water required per unit of product; substitution of air and other media for water wherever possible; in-plant water surveys and employee educational programs to reduce use of water; and recirculation of water through the use of cooling towers and other devices in order to achieve multiple use of water.
2. The use of ocean salt water and brackish water in place of fresh water wherever possible.
3. The direct reuse of treated municipal waste waters for industrial purposes.
4. Cooperation with municipalities in handling waste disposal problems.
5. Cooperation with state and interstate regulatory agencies in carrying out stream surveys and recommending desirable operational procedures.
6. Cooperation with the Federal Government in its research, data-gathering, and educational programs.
7. The installation and operation of waste treatment devices.
8. Continued industrial research and exchange of information on difficult, unsolved waste treatment problems.

Thus, there is every indication of a marked increase in conservation of water by industry. In a short paper such as this, it is impossible for me to tell the story of how each great American industry is implementing its program in the field of water usage and water pollution control. Therefore, I shall confine myself to the story of the pulp and paper industry, with which I am most familiar. This will make my presentation more concrete and at the same time be suggestive of parallel developments in other industries.

Each industry carries on its efforts at the plant level, the company level and through various industry committees, associations and organizations. In the pulp and paper industry, two of the most active organizations in this field are the National Council for Stream Improvement and the Sulphite Pulp Manufacturers' Research League. The National Council for Stream Improvement was formed in 1943, as a result of the efforts of a far-sighted group of pulp, paper and paperboard industry leaders who recognized the need for an industry-wide and sustained effort to solve the industry's stream pollution problems. It was organized to develop, through research, solutions to the pulp, paper and paperboard industry's waste disposal problems and to make those findings available to members for application in actual mill operations. Supported by pulp, paper and paperboard manufacturers in the United States, the National Council's operations are financed by dues assessed on a tonnage basis. It operates on a regional committee basis through a paid staff. These regional and sectional committees, through their chairmen and members have made a great and valued contribution to the industry's program. Management functions are centered in a central operating committee and a board of governors consisting of executives representing the various broad types of pulp, paper and paperboard manufactured in the United States. Research is conducted at regionally located institutions and the results of this research are disseminated to the industry. Information on stream improvement problems is furnished to members through the National Council's technical staff and regional resident engineers.

Among the important policies adopted early by the board of governors are: cooperation with State, interstate and Federal agencies in the water pollution control field; nonintervention in political and legislative matters; and recognition of the basic, fundamental concept that research is merely a means to an end, and that unless research findings are reflected in improved waste disposal methods the research program is, to a large extent, nullified. The wisdom of these policies has been frequently demonstrated, particularly that relating to cooperation with public agencies. Without such cooperation, much of the progress achieved could not have been accomplished.

The Sulphite Pulp Manufacturers' Research League, while different in some aspects is also a cooperative research arm of the pulp and paper industry, established and governed in somewhat the same manner as the National Council. By attacking specific industry problems, as well as undertaking general basic research, this group is also making outstanding contributions in this field.

The problems involved in pulp and paper industry waste disposal are many and diversified. Different mills produce different wastes, and the characteristics of the receiving waters vary substantially depending on hydrology, waste load, assimilative capacity, usage and regulatory control. Thus, in a narrow sense, each situation constitutes a different problem. Through the years, however, an over-all and broader concept of the basic problems has emerged. Under this broad concept the numerous individual situations can be categorized under the following general headings:

1. Stream Analysis and Reoxygenation of Rivers.
2. Suspended Solids Removal, Dewatering and Disposal.
3. Aquatic Biology.
4. BOD Reduction.

Throughout the years, a definite research pattern has been established. Research institutions are selected on the basis of their facilities, including equipment and manpower, their past experience in the problem under investigation, and their proximity to the area in which the problem under investigation exists.

The research procedure begins with an investigation of the literature. From this and other sources, possible leads are selected for laboratory investigations. If this investigation shows promising results, further studies are instituted on a bench or field type pilot plant. From such pilot plant studies, cost and design factors are determined and, if these are favorable, the process is made available for actual mill application by members.

The following are some of the institutions whose research facilities have been utilized in the pulp and paper industry's research program:

Mellon Institute of Industrial Research
Institute of Paper Chemistry
University of Michigan
Rutgers University
Purdue University
Louisiana State University
Virginia Polytechnic Institute
Oregon State College
Washington State University
University of Georgia
North Carolina State College
University of Maine
Kalamazoo College
Bates College
New York University
Manhattan College
Columbia University
Western Michigan University
Syracuse University
University of Florida

The accomplishments of the paper and pulp industry's pollution abatement activities can be measured by several criteria: reduction in total pollution load; reduction in pollution load per ton of product; conservation of fibre, which can be translated into wood conservation; and conservation of water.

In all of these, the industry has made notable, in fact phenomenal, progress. In the past 20 years, annual production of paper and paperboard soared from 13,500,000 to 34 million tons, an increase of over 150 percent. The waste load, on the other hand, is now less than it was in 1939. To put it another way, the waste load from the average ton of paper and paperboard has been reduced by more than 50 percent since 1939. This has been accomplished without any tax-derived subsidies from any governmental agency and has not been the resultant of any Federal legislation on the subject. It involved the expenditure of more than $100 million by companies in the industry.

During this same period, the industry reduced its average fibre loss from 5 percent to less than 2 percent, a saving of over a million tons of fibre and a vast reduction in the waste load. From the conservation viewpoint, this saving is significant, representing as it does over one and a half million cords of pulpwood.

This reduction in the pollutional effect of paper industry wastes was accomplished by a number of different methods. These include effluent treatment, new or novel waste disposal procedures, reduction of solids losses by recirculation of process waters and use of solids removal equipment, retention of increased percentages of wood substances in the finished product, more efficient recovery of chemicals and heat from spent pulping liquors, new recovery systems applicable to certain pulping liquors, and recovery of byproducts.

Vast economy in water use has also been accomplished during this period. Today, when great concern is being expressed in connection with future water resources, the industry can look back with satisfaction on an average reduction in water use of more than 50 percent per average ton of production during the past 20 years. Even by 1954, the industry was making its intake water do the job of 2½ times as much water.

The pulp and paper industry was the first to employ stream analysis techniques, on a wide scale, for forecasting the effect of waste effluents on receiving waters and predicting the degree of waste treatment required to meet predetermined water quality criteria. Through a research project, started at Manhattan College and continued at the University of Michigan under the direction of Prof. C. J. Velz, not only was effective use made of existing methods of analysis, but valuable new and refined techniques were developed. For example, in addition to forecasting the dissolved oxygen sag curve resulting from the discharge of organic wastes and the effect of bottom deposits on dissolved oxygen levels; waste storage requirements and discharge schedules can now be predetermined for locations where runoff is highly seasonal and mill effluent must be impounded for long periods.

Stream analysis techniques thus developed are widely used for determing waste impoundment and release schedules. Several large impoundments of this type are in operation by individual mills where it is necessary to regulate waste discharge to peculiar runoff patterns caused by natural conditions and/or peaking hydroelectric power stations upstream. Where sufficient and suitable land is available for developing large impoundments, maximum utilization of the entire dilution capacity of the annual runoff can be realized. In this way, downstream users are protected from wide variations in water quality caused by effluent discharge disproportionate to the runoff.

of any Federal legislation on the subject. It involved the expenditure of more than $100 million by companies in the industry.

During this same period, the industry reduced its average fibre loss from 5 percent to less than 2 percent, a saving of over a million tons of fibre and a vast reduction in the waste load. From the conservation viewpoint, this saving is significant, representing as it does over one and a half million cords of pulpwood.

This reduction in the pollutional effect of paper industry wastes was accomplished by a number of different methods. These include effluent treatment, new or novel waste disposal procedures, reduction of solids losses by recirculation of process waters and use of solids removal equipment, retention of increased percentages of wood substances in the finished product, more efficient recovery of chemicals and heat from spent pulping liquors, new recovery systems applicable to certain pulping liquors, and recovery of byproducts.

Vast economy in water use has also been accomplished during this period. Today, when great concern is being expressed in connection with future water resources, the industry can look back with satisfaction on an average reduction in water use of more than 50 percent per average ton of production during the past 20 years. Even by 1954, the industry was making its intake water do the job of 2½ times as much water.

The pulp and paper industry was the first to employ stream analysis techniques, on a wide scale, for forecasting the effect of waste effluents on receiving waters and predicting the degree of waste treatment required to meet predetermined water quality criteria. Through a research project, started at Manhattan College and continued at the University of Michigan under the direction of Prof. C. J. Velz, not only was effective use made of existing methods of analysis, but valuable new and refined techniques were developed. For example, in addition to forecasting the dissolved oxygen sag curve resulting from the discharge of organic wastes and the effect of bottom deposits on dissolved oxygen levels; waste storage requirements and discharge schedules can now be predetermined for locations where runoff is highly seasonal and mill effluent must be impounded for long periods.

Stream analysis techniques thus developed are widely used for determing waste impoundment and release schedules. Several large impoundments of this type are in operation by individual mills where it is necessary to regulate waste discharge to peculiar runoff patterns caused by natural conditions and/or peaking hydroelectric power stations upstream. Where sufficient and suitable land is available for developing large impoundments, maximum utilization of the entire dilution capacity of the annual runoff can be realized. In this way, downstream users are protected from wide variations in water quality caused by effluent discharge disproportionate to the runoff.

Through the years, a vast store of hydrologic and other data concerning rivers in this country have been accumulated by the National Council. This information is available to National Council members and others having a proper interest in these matters. A large amount of basic data on rivers, which was originally obtained by government agencies, is also part of this file which is constantly being expanded.

For many years, the industry has been interested in finding a means whereby natural reoxygenation could be supplemented so that dissolved oxygen levels could be raised in sections of streams where critical conditions occur.

Three means of doing this are under intensive investigation. One of these is to develop improved aeration equipment and explore the use of surface-active agents as a means of increasing the rate of solution of oxygen. Studies directed toward this end are supported by the industry at the University of Maine. Headed by Dr. S. A. Zieminski, of the Department of Chemical Engineering, an aeration device has been developed which appears capable of dissolving considerably more oxygen per unit of power applied than direct diffusion. This project has also demonstrated the fact that certain chemicals, such as the higher alcohols, when introduced with the air in vaporized form have a pronounced effect upon the rate of solution of oxygen. Experiments are continuing to determine if there are more effective chemicals than those presently known which could be economically applied.

Another method employs the introduction of air into the turbine draft tubes at power stations. This method has been applied by a number of mills and is being intensively studied by the Wisconsin Committee on Water Pollution in cooperation with the Sulphite Pulp Manufacturers' Research League. While its application is limited to the coincidental presence of a hydroelectric power station and low oxygen levels in rivers, it has the great advantage of requiring no elaborate installation of equipment, and is the most efficient method to date for dissolving oxygen in water. Power is lost from the turbines on introduction of air to about the same degree as that which would be required to dissolve oxygen in water by mechanical means.

Still another method which has been given considerable attention recently, both in this country and Europe, concerns the ability of weirs and cascades of various types to dissolve oxygen in water. This line of attack embraces both the improvement of existing overflow structures and the construction of new ones with this factor in mind.

It appears from the review above that artificial stream reaeration will receive increasing attention and application in the future and that this means of supplementing the purification capacity of streams will in time become common practice.

The removal of suspended solids from pulp and papermill effluents has received more attention than any other phase of stream pollution control. Since such solids can interfere with downstream uses, deposit on the stream bottom and absorb dissolved oxygen, and float in unsightly masses on the water surface, they bear obvious witness to pollution.

The first step taken by the industry toward suspended solids reduction in mill effluents was to remove bark and rejects which could be successfully screened from mill effluent, and subsequently dryed, burned or dumped. Following this, fibre recovery became the objective. In this activity, the industry has made an almost incredible record. Coupled with water reuse, this has proved to be a true conservation measure, since, by these practices, water usage has been cut to less than 50 percent of that previously employed. Fibre savings amount to a million tons annually.

While mills have grown tremendously in productive capacity, the quantity of water available for effluent dilution has not, on the whole, increased. This fact, together with greater use of waste papers and other materials in manufacturing which contribute more suspended matter to effluents, has made it necessary for many mills to remove a very high percentage of suspended solids from the effluent. The residue collected from the removal operation is generally gelatinous in nature, which causes the separation of additional water to be extremely difficult. This means that a large volume of very watery sludge must be disposed of and, preferably, be dewatered prior to disposal.

Most States regulate the discharge of suspended matter in industrial effluents. Requirements vary widely. Some are concerned with their visible effect on receiving waters, others their concentration in the plant discharge, and still others specify that effluents be treated in a manner whereby removal of such solids to a certain degree can be achieved. Because of such regulations, it is seldom permissible to build a mill today without providing for the removal of a large percentage of the suspended matter present in the waste. Every indication is that regulations regarding the discharge of suspended solids will become more stringent since the increased use of surface waters for recreation will increase public pressure for their removal to a higher degree.

For many years, research has been conducted by the industry toward determining the best methods of suspended solids reduction for various mill effluents, the variables affecting their efficiency, and the effectiveness of coagulating chemicals in clarification. Accompanying this effort, there has been extensive development and application work carried on by the mills, equipment and chemical companies. In addition, survey studies made by the industry have aided in evaluation of the various methods, and have been of assistance in establishing present practice. The institutions that have played a part in these investigations have been Mellon Institute, Rutgers University, Kalamazoo College, Western Michigan University, and Syracuse University. The industry's research groups have also contributed to a substantial degree through their surveys, operation of pilot plants, and contacts with individual mill solids reduction programs. In general, excellent progress has been made by the industry in removing suspended matter from mill effluents.

Extensive research and experimental operations have also been carried on by the industry on problems related to aquatic biology and biological treatment of effluents for reduction of biochemical oxygen demand. Industry research projects at many colleges and universities, and field studies at many of the industry's mills are involved in this work. It is impossible to go into much detail on the difficult, complex, and frequently frustrating aspects of these problems. I believe that I have already given you a good picture of one industry's efforts.

In other industries, similar efforts are being carried on by such groups as the Committee on General Research of the American Iron and Steel Institute, especially its Water Resources Management Subcommittee; the Committee on Disposal of Refinery Wastes of the American Petroleum Institute; the Land and Water Use Committee of the National Coal Association; and the Water Pollution Abatement Committee of the Manufacturing Chemists' Association. I have mentioned only a few and have slighted a great many industries and organizations by not mentioning them.

## CONCLUSION

I have endeavored to suggest in concrete fashion some of the needs and obligations of industry in regard to wise use of our water resources. For a number of years, industry has been very cognizant of problems in this area. I am hopeful that this paper has properly indicated the assumption of responsibility by industry in these matters and that there is no intention to shirk this responsibility. It is evident that we are only beginning to make significant break-throughs on some of the difficult, complex problems. Industry is endeavoring to learn more of the present characteristics of over-all industrial water use and waste disposal through conduct of a national "Water In Industry" survey, such as was accomplished in 1949.

In most States, an industrial company must notify the appropriate state agency of changes in processes and changes in disposal systems as well as new installations. As the years go by, there will be considerable upgrading of industrial practices. Many States are doing an excellent job of promoting the cause of wise use of water resources without disrupting their own economy. Industry is cooperating because it is willing to contribute to the attainment of improved stream conditions. What industry does object to is being forced to make large expenditures to meet arbitrary standards that are unrelated to the conditions in the particular stretch of stream in question. In short, industry is perfectly willing to spend money to improve demonstrated problem situations in particular areas, such as oxygen depletion or sludge deposits, but application of abstract, theoretical criteria can easily result in the imposition of uneconomic penalties on our entire system of production and consumption.

It is inevitable that we will have increases of population and to support this increase in population we must have industrial development. In existing areas of moderate to heavy population and industrial density, it is only reasonable or equitable to conclude that the self-purification action of the stream must be considered as an integral part of pollution abatement. Generally, no two waste problems can be handled in the same manner. A blanket requirement as to method of treatment or degree of percentage removal is not consistent with the complexity of the problem. The extent of self-purification is dependent upon specific characteristics inherent in each body of water and these characteristics may differ markedly from place to place. Further, to evaluate this ability to recover, such factors as time, temperature, distance, weather conditions, volume of flow, velocity, reaeration, dispersion, type of waste, etc., must be considered.

There is little doubt that economics are a major factor in all waste treatment. Whether it be a municipality or an individual industry, each will search for the most economical means of handling its problems, taking into consideration the self-purification ability of the receiving body of water. Excessive waste treatment requirements may prevent industrial growth or make its position untenable. As pointed out by Morgan, in *Iron and Steel Engineer*, July, 1960, in regard to the industrial plants along the Mahoning River in Ohio:

> These plants are dependent upon the river, and considering that their monthly payroll plus goods and services purchased locally totals probably as much as $12,000,000 per month, the economic health of the community is in turn dependent upon the competitive position and prosperity of these same plants. The state regulatory agency has, so far, recognized these fundamental facts and has treated the Mahoning as an industrial stream, whose primary use is to serve the plants and through them the communities on its banks.

It is obvious that the many kinds of efforts presently being carried out by industry to attain wise use of our water resources must be continued and in some cases stepped up or accelerated. The public will have to accept the fact that the cost of maintaining water quality must be and is part of the cost of production and must be paid for by consumers. This is the appropriate private enterprise way to accomplish the result and undoubtedly the least costly way. Industry is not trying to get a free ride from anybody, but in return it asks for freedom to operate and freedom to make decisions. This will provide social advancement as well as the economic advancement that sustains our society. Historians have noted that over the centuries Oriental despotism has been associated with centralized control of water resources. Unless it is the decision of the American people to alter our economic system and abandon our private enterprise approach, the only progress that can be made by private economic units will be the result of having control and application of solutions at local or regional levels in order to maintain the flexibility necessitated by the fact that different conditions surround every problem of wise use of water resources.

**Dr. WOLMAN.** We are indebted to you, Mr. Pasek, for presenting the position of industry with respect to the pollution abatement problem. I would take only a moment to point out, Mr. Pasek, that you demonstrated a high degree of courage by commenting on the fact that we are not, in fact, on the verge of disaster either in quantity or quality of the surface and underground waters of the United States. I think the record would show that that comment is well within the realm of accuracy.

When I admire your courage, it is because in every Conference such as this, the advocates of the precipice type of approach—namely, that we are just about to fall over the edge of the precipice in this kind of a situation—I suppose is generally suggested because it lends drama for the solution of the problem. It is drama that we are searching for in order to arrive at a better understanding on the part of the public and, of course, a better acceptance on the part of the public and of industry of the necessary bill.

It is important, however, as Mr. Pasek points out, to keep reminding ourselves that while we are seriously interested in the total problem of the management of our water resources, that we should not forget we are walking either in a crisis or on the verge of disaster. It just isn't so. I, for one, for example, have been increasingly bored over the last ten years by the repetition in every one of our popular and scientific journals with the restatement, in case of the New York City water shortage, that this was a prime example of an 8 million population literally on the verge of disaster because we were running out of water in the New York area. Nothing could be further from the truth. It happens to sit in one of the richest water resource areas in the United States. And what I think the journals should learn to do is to say that this was the result of delayed planning and execution, delayed management of the very rich resources in that area that put New York City for a considerable length of time on rations. Anybody looking over that area can not escape the conclusion that this could hardly be listed in the United States as an area devoid of potential water resources for that great metropolitan area, not only until the year 2000, but considerably beyond. As one of the minor prophets myself, I don't like to see very much beyond the year 2020. This is about as far as I think we could probably guess.

## DISCUSSION

### JAMES M. GILL,

***Plant Manager***

***Ethyl Corporation, Pittsburg, Calif.***

The paper by Mr. Pasek includes several excellent ideas and aspects which, I believe, merit further consideration. The value of water throughout the nation is increasing. The availability of a good, clean water supply is a most important factor in determining the limits of economic growth for any area of our country. The needs for water are obvious and the obligations of those who make use of it on its way to the ocean are becoming increasingly clear.

While it is believed, as Mr. Pasek stated, that there is an adequate supply of water to meet the requirements of our expanding economy in the foreseeable future, the distribution of the available water supply is of considerable concern in some areas of the country. The State of California is one such area.

Although the State has sufficient water to meet its needs, the available water is concentrated in the northern part of the State, while the southern part is extremely short of water supply. As part of the program to provide better distribution of the available water, the taxpayers last month approved a 1.75 billion dollar bond issue for facilities to store and transport water from the northern part of the State into the southern area. This is a significant expenditure from any standpoint and will be reflected in the total economy of the State; moreover, it may be only the first step in a ten plus billion dollar expenditure before the system is finished. The redistribution of water resulting from the new plan will have a significant effect on water pollution activities within the State. The users of this newer, more expensive water will be handling a valuable commodity and must make maximum use of it without undue pollution. It will also mean that many industries in Northern California that have traditionally benefited by the diluting effect of the water now scheduled for diversion to Southern California will have to reappraise their water pollution abatement facilities in light of the new flow conditions in streams to which they now discharge their waste products. It is inevitable that many other parts of the country will face similar needs and problems in the future.

The extreme differences in available water and water pollution problems between the various areas of California were recognized and considered when State water pollution legislation was enacted. The State is divided into regions according to watersheds, with each region being under the control of a Regional Board composed of representatives of major types of water users in the region. These Regional Boards operate with a high degree of autonomy, with a State Board functioning as a policy-making and coordinating group. This type of organization allows the flexibility required to set pollution requirements based upon a multiplicity of factors which vary from area to area.

Regardless of the methods used in controlling pollution, industry has an obligation to itself and to the public to present its views in any legislative matter involving regulatory measures in the field of waste control. Obviously, industry's position cannot be that of opposing necessary controls of water pollution but the approach should be that of making certain that the controls imposed are constructive measures based upon sound scientific and economic factors, contributing to the region's total economy and well-being. In some instances, regulations have been based on public outcries and political expediencies. The cost involved in conforming to such regulations has been, on some occasions, greater than warranted by the small benefit that may have been achieved.

All groups concerned must make every effort to insure that expenditures for pollution abatement facilities will result in worthwhile improvements in water quality. How can this be done? First and foremost, there must be available adequate and sound data on which to define clearly the specific problems involved and to indicate the requirements that must be met to maintain water quality at the highest reasonable level. As Mr. Pasek has mentioned, there are a number of industry committees, associations, and organizations that attempt to gather such information and sponsor research activities in appropriate fields. Local, State, and Federal Government have also contributed to research activities and a better understanding of the problems involved. In particular, the United States Public Health Service, under whose auspices we are meeting today, has made some significant contributions in the field of water pollution research.

All of these efforts must be continued and, in many cases, expanded. There is no substitute for knowledge in the field of water pollution abatement. It is not enough to simply say we must keep our waters clean. How clean is clean? At what point is a stream polluted? We must continue to recognize that use of waterways for dispersion and assimilation of waste effluents is inevitable and proper, provided provisions are also made for the preservation of other beneficial water uses. This is necessary if our community and industrial growth is to be maintained for the greatest total good of our society. To do this, however, we must continue to expand our field of knowledge in water pollution. Research must provide us with answers to, "How clean is clean?" and "At what point is a stream polluted?"

It is most important to recognize that the science of water pollution control, as Assistant Surgeon General Mark Hollis expressed in an address at the California Institute of Technology in May of this year, is far from a true science but is, in fact, a science in evolution replete with gray areas yet to be resolved. A great deal of research on the waters of this country will be required to assess their present condition and extent of pollution as well as changes in pollution resulting from the increasing growth of the Nation. A scientific approach must be used to determine the contribution of various types of discharges to the total stream pollution problem. Regulations may then be based on these factual findings and applied on a local basis.

As Mr. Pasek has stated, industry has made substantial investments in the development and construction of water pollution abatement facilities to maintain water quality at the highest reasonable level. Industry has the obligation to continue this work and to search for new methods of waste treatment. New processes are continually presenting new wastes which may require treatment before discharge. Research must be carried out to determine the most effective and efficient treatment of these wastes. Consideration of waste treatment facilities is now more than ever an integral part of new plant design. The cost of pollution research and pollution abatement facilities must be considered as part of the cost of doing business in today's society. Over the past decade, these costs have constituted an increasing percentage of new plant investment. Significant steps in pollution abatement have been made in the past, and there is no reason to believe that this trend shall not continue until the ultimate maximum beneficial usage of our waterways is obtained.

In summary, the national economy requires that industry have tremendous quantities of water to maintain its current growth. To assure that industry has a supply of suitable water and to maintain its position in society, it must continue to spend time, money and effort to control its waste effluents. Much research will be required to develop the science of water pollution control to the point that it adequately benefits all segments of our economy. Industry must insist that all regulatory actions be based on sound, scientific and economic considerations. Dispersion and assimilation of wastes is an inevitable and proper use of receiving waters, provided other beneficial uses are also protected. Industry has made significant strides in the field of waste abatement, but increasing effort will be required of all of us, industry and communities alike, if we hope to keep the streams in proper condition, despite the inroads of an expanding economy.

## Panel III

### General Discussion

**Mr. ADAMS.** This question is directed to Mr. Forsythe and was asked by Prof. Don Bloodgood, Purdue University: "***You use the***

***term 'navigable stream' in defining area of jurisdiction of proposed Federal law. What do you mean?"***

**Mr. FORSYTHE.** It goes to the very essence of what you are going to do in the matter of Federal regulation. As you know today, very briefly, we can go in with regulatory powers if we find, or someone finds or invites us to come in, and attack a pollution situation which is interstate in nature—one which is a hazard to the health or welfare or persons in a State other than that in which the discharge originates.

It has been found by the people who work with regulations that this particular definition is one which has impeded the clean-up in certain areas of our streams and our rivers. It has led to more costly and slower regulatory activity.

Now, if you are going to change the definition under which the Federal Government can come in, two of the definitions which have been suggested are interstate navigable streams and navigable waters or streams. Obviously, 'interstate navigable' is more narrow in concept than navigable waters, yet, more liberal than the definition we are working under at the present time. If you accept interstate navigable waters, you leave out some coastal waters which are important in the problem of pollution.

So, when I said "navigable," I was suggesting that you consider the matter of Federal regulation whether the Federal Government should go into the navigable waters as such, including coastal waters. It would, of course, leave out undersurface waters, but would give the Federal Government and the Public Health Service more authority and would allow them to do a job more effectively and efficiently and we believe at less cost. That is what I meant by that particular type of definition.

Let me say one thing in closing out this question. Several comments have been made, which indicate to me, at least, that most of us here on the panel and I suspect in the room have vast areas of agreement. The need for research and technology, laboratory work, proper personnel, seeking out answers to the problems we have.

I might suggest, too, that in my paper which I did not have a chance to read, there were certain other activities which I recommended in which there may not be too much argument here on the panel, and which can be used to help the Federal Government in its activities. For instance, one might consider assistance to industry in the form of credit accommodations or tax incentives for the high cost of waste treatment which we have heard about here today in connection with industry activity. We believe in the Public Health Service, the Department of Health, Education, and Welfare, in this administration, that Federal installations have a great responsibility for cleaning up their waste disposal in streams. This program has already been launched by President Eisenhower. And in my paper, I take a very strong position to the effect that Federal installations must play a more active part in this.

I have called for consideration of change in the individual project grant ceilings under the present waste facilities construction program; also extension and expansion of program grants to allow for more research and more activities on the part of the States. These are some of the activities and suggestions which I have made in my paper which I believe, when coupled with the recommendation on the question referred to here, will give us a better program from the standpoint of the Federal Government, without undue restrictions upon localities, States, and industry.

May I say to the chairman I certainly agree with him. I do not think anybody in this Conference is going to say that we are at the precipice, that we are going to fall over into a situation of pollution which cannot be considered. We are addressing ourselves to a resource. We are addressing ourselves to the problems that we have in connection with that resource today, and we are trying to anticipate what we might do to get a sensible program for the future. Then perhaps we might never reach that day when we come to a situation where arbitrary and quick action would have to be taken on a crash basis which would not be beneficial either to the Federal Government, to the States, industries, or anybody else concerned.

**Mr. ADAMS.** The next question is for Karl Mason of Pennsylvania, who is quoted by Harold H. Hair of the U.S. Chamber of Commerce: ***"You say the States have failed to come to grips with the knotty problem of standards. Why do you not press for them to do so rather than advocate that they pass the buck to the Federal Government?"***

**Mr. MASON.** I think I can answer that by saying that in the comparatively short period of years that I have been involved in this type of work, there has been much effort, I believe, on the parts of the individual States and through their interstate and national organizations to come to some agreement on just what are the standards for water quality. What are the criteria we should strive for to determine the type of treatment that is necessary for a specific use, whether it be for public water supply, recreational purposes, or industrial? All I can say is that I feel the time is long past when we need to have some agreement at a national level on these questions.

Since we have been unable, to date, to do it through our own organizations, perhaps if all of us—the States, industries, municipalities and interested organizations get together under the leadership of the Public Health Service, we may come up within the near future with a set of acceptable water quality standards.

**Mr. ADAMS.** This question is addressed to Mr. Fugate and was asked by J. H. Skeen of U.S. Rubber Co. ***"What do you mean, by***

***your reference to the expanding and overriding interests of the Federal Government in its conflict with the State governments over water matters?"***

**Mr. FUGATE.** It has been interesting to me to sit here and hear the comments from those others who come from water rich areas of our Nation, as I come from one of the water poor areas of the country, relatively speaking. It is my observation over the past several years that water is not a local resource. We need it locally. Once we have used it, it continues on its way, in our particular instance, some 40 miles south of us and becomes an interstate commodity. It becomes, shall we say, of local interest in a community in Oklahoma. It goes from there into Arkansas, to Louisiana, and perhaps Mississippi. To me, the control and development of that resource must be more than a matter of concern of my community, of your community, of my State or the State of Senator Kerr or any other particular community or State in order that that resource be developed to the maximum with the greatest reuse of it and its potential.

It appears to me that our experience in the past and our delay in meeting this problem, a delay even evident in our great city, New York City, that we must give recognition to the fact that water in any locality has a national characteristic, a greater than local characteristic. What we do in our community affects those below us. What those above us in a watershed do affects us. And I think that it is only by the interjection, if you will, of the necessary overriding Federal authority, the recognition of the national importance of this problem, that we can reach a solution of it within a reasonable time.

I, personally, am not one of those who are afraid of government, perhaps because I am in it. I am not afraid of either working with or under our State governments, nor has my association with the Federal Government in water projects led me to think that I have any reason to fear the national government in this problem.

**Mr. ADAMS.** S. Leary Jones (Tennessee Stream Pollution Control Board), will you read this one paragraph resolution that you have asked the privilege of presenting to this Conference?

**Mr. JONES.** This was a resolution that was passed on December 6th at Chicago at the Third Annual Meeting of the Interstate Conference on Water Pollution. I received it yesterday, and I think the group would be interested in it. The fact that there have been so many statements advocating additional Federal control, I believe this should go into the minutes.

The first part of the resolution, I will skip. It agrees with many of the items in the proposed bill.

But on this part, it reads: "Be it further resolved that this Conference"—and this was the Interstate Conference—"vigorously opposes the extension of Federal regulatory jurisdiction over intrastate pollution by means of a general assertion of enforcement jurisdiction over 'navigable waters' or by any other means which would interfere with the State performance in this field."

**Mr. ADAMS.** The next question is addressed to Edward J. Cleary by G. A. Howell of the United States Steel Corp.: ***"To obtain the fullest beneficial usage of our streams, effective regulatory bodies have adopted the practice that the discharge into the stream should be governed by the full assimilative capacity as measured at the point of use. What is your thinking on this?"***

**Mr. CLEARY.** Mr. Howell, that question has all the elements of the proposition that occupied the theologians of the 15th century. Then they weren't concerned with exploding population. The question was: How many angels can dance on the head of a pin? The answer, it was finally concluded, depended on the size of the head of the pin and also the dimensions of the angels. Obviously, this called for some judgment.

I think the matter of the use of the assimilative capacity of a stream is also a matter of judgment—engineering judgment—and it calls for appraisal and analysis of such factors as: location of the water uses below the discharge; what water uses are affected and the standards adopted for the protection of these uses. So, to state that the full assimilative capacity of a river should be used calls for a lot more time than we have to debate at this particular session.

I would emphasize that the assimilative capacity of a stream cannot be ignored in any economic analysis and determination with regard to the treatment requirements. But I would suggest that we do ourselves a disfavor to debate the technical aspects of this issue when we are faced with less sophisticated matters that call for immediate attention. For example, there is much obvious pollution that needs to be abated without any reference to economic, engineering or any other types of analysis. When I learn that a mill puts 136,000 gallons of waste oil a month into a river, I don't need to make a study of the K factors of assimilation in order to determine that this is contrary to the public welfare. Or, when I read at the hearings on a major river that tons of pounch manure and blood and entrails are discharged from an abattoir I hardly think it is necessary to make a scientific study of the assimilative capacity of the river. These are obvious conditions of pollution that can be seen and smelled. This is what the public wants cleaned up. The public is not concerned with the B.O.D. of the stream or the number of particles of suspended solids or any other sophisticated parameters of pollution.

We, too, must be concerned with getting some obvious pollution cleaned up. Therefore, the assimilative capacity question is one that might be delayed until the obvious things have been done first.

**Mr. ADAMS.** This is a question for Mr. Pasek from Everett E. Thuener, from the Chamber of Commerce of Schenectady, N.Y.: ***"Could the installation of weirs and other agitating media on locks in a navigable river aid, to any extent, in raising the amount of oxygen in the water of that river? If so, has it been done and where?"***

**Mr. PASEK.** This, again, of course, is a highly technical question. In my paper, I suggested that both in Europe and in this country such devices are being tested, researched, designed, and redesigned. There is some prospect for this type of device being used to advantage. At this time, I know of no, what might be termed, commercial development in use. There could well be.

There are technical people here that could answer the question better than I. I think that is sufficient answer to the question.

**Mr. ADAMS.** This is a question directed to Mr. Gleason by Daniel W. Cannon of the National Association of Manufacturers: ***"Would you care to comment about the success in the Pittsburgh, Pa., metropolitan area of achieving a $100 million sewage treatment project financed by revenue bonds of the Allegheny County Sanitary Authority?"***

**Mr. GLEASON.** Mr. Chairman, that is a very difficult question for me to answer because I am not familiar with either their problem or their solution in that one area. I can only answer that of the two areas that I am particularly familiar with, that of my own metropolitan area surrounding the city of Portland, Oreg., and that of the metropolitan area of Detroit, that it appears that revenue bond financing with complete utility type payment and sufficient funds collected for connection and monthly charges to defray the entire expense is by far the more desirable type of financing over anything that we have found up until now.

**Mr. MASON.** I think, as Mr. Gleason mentioned, that this is a very complex problem. I would like to make only a brief statement saying that I think the accomplishments that have been attained through the present interceptors and sewage treatment works of the Allegheny County Sanitary District certainly are evidence of the wholehearted cooperation between our interstate agency ORSANCO, the State Sanitary Water Board, the city of Pittsburgh and all of its officials. The same applies to Allegheny County and also to the very close cooperation received from the industries and smaller municipalities in that area that put their money on the line in the sum of $100 million to collect and treat the sewage from that extensive metropolitan district in Southwestern Pennsylvania.

## PANEL III, Afternoon Session

**Dr. Abel Wolman, *Presiding***

We will open our session this afternoon with a talk by R. G. Lynch of the *Milwaukee Journal.* Mr. Lynch is well know to many of you as a leading figure in the field of conservation.

# Public Awareness and Citizen Responsibility

R. G. LYNCH

***Columnist, Milwaukee Journal***

Mr. Chairman, ladies and gentlemen—

I think that most people are aware that there is a pollution problem. They just don't pay attention to it unless it affects them directly. That is important to keep in mind.

What is needed is a public sense of urgency.

As for citizen responsibility, that is just a fine-sounding expression. In the broad sense, I think, it never really exists except in times of emergency, and then it is not truly responsibility, but fear, anger or outrage.

Do you think that the citizens of St. Joseph, Mo., recognized any responsibility when they voted down sewage plant bonds last spring? And certainly they were aware that their sewage was going down the Missouri River, creating problems for other communities.

I see by the Conference program that I am the only representative on any panel of mass communications. This makes me wonder if more realistic thinking is not badly needed. Before you get very far with these efforts, the best minds in the newspaper, radio and television field and in advertising and promotion had better be assembled for a panel discussion. All I can give you is one man's ideas about the basic reason for the failure of pollution prevention and the only means by which pollution can ever be adequately controlled.

All of us might as well be meeting and talking in a vacuum if the newspapers and radio and television people do not spread the word. And I can tell you right now that they will not spread enough of it widely enough; and that relatively few of the readers or listeners will pay attention to it, much less talk about it as something they should do something about.

All of the things they are talking about in the other rooms, and the things preceding speakers have talked about in this room, would resolve themselves easily in the face of public demand.

Cleaning up water and keeping it reasonably clean—really is no problem. And, believe me, I know something of the appalling dimensions and complexity of this galloping national disease. I mean that science and technology have provided the tools and are capable of providing better tools as needed. All we have to do is get at the job in dead earnestness on the whole broad front.

That will not happen until the people demand it, for it will take money—a lot of money. The other problem on the horizon, that of shifting the emphasis to disposal of wastes elsewhere than in water, will be resolved only in the same way. The public must will it.

It is going to take a hard sell. When it comes to dollars, people are subjective—selfish. Pants pocket economics takes precedence over big economics and public welfare. Citizen resistance to higher taxes can amount to a general allergy. How else can we account for the defeat of bond issues for such basic things as schools and sewage treatment?

There's a story about Noah Webster, the dictionary man. Bathing, it's said, was abhorrent to him. One time a woman, standing behind him at a gathering, said to a companion, "That's Noah Webster; he smells badly." Webster turned and said, "Lady, *you* smell badly; *I* stink!"

The story usually is told to emphasize the misuse of the adverb. I tell it to emphasize a word: stink. Some people think it is not a nice word. To me it is a working word; it has impact. Nice words, like nice guys, as Leo Durocher once said, don't win.

Without stink, it might be said that we would have very little pollution control. If people cannot smell it, or see it, or taste it; if it does not cause illness—in short, if it does not affect them directly, they do not care whether anything is done about it or not.

Sometimes even when they can smell it and see it they will do nothing about it unless forced.

On the fringes of Milwaukee's metropolitan complex, subdividers in ignorance of the law have built homes on land incapable of absorbing household wastes—a condition familiar wherever there is urban sprawl. State inspectors tell me that home owners in such areas complain about their neighbors' septic tank seepage into ditches and low spots but when they find out that they have the same problem and can't solve it without a lot of expense, they just shut up, willing to live with the nuisance and the health hazard.

People don't get worked up over oil dumping in the ocean or the Great Lakes—not even Senators—or about radioactivity in the Tennessee River, mine acids in the Ohio or packinghouse wastes in the Mississippi, not unless it is right under their noses.

Dead fish and dead ducks in the Milwaukee River last year aroused some comment; and when beaches on Lake Michigan were closed because of pollution there were letters to the editor. But when storm sewers overflowed into sanitary sewers last spring and backed up a stinking mess into basements, the uproar had aldermen and county supervisors jumping—and they're still clamoring for remedies.

So, I say to you, any hope for real action against pollution must lie in an appeal to this subjectiveness. Self-interest must be the target. Put the story into ordinary language, dramatize it, localize it, personalize it.

The same people who vote down sewage plant and school bonds buy television sets, transistor radios to carry about, power lawn mowers for postage stamp lawns, clothes dryers, air conditioners. Some of them probably spend more in a year on cigarets than the bonds would cost.

I do not criticize their spending. I merely point out that they will put up money for things they want—in fact, will go into debt. And in this Nation the art of making people want things, including what they don't need, has been developed to the point where it dominates our economy, if not our culture.

This talent, the best that can be had, must be recruited to make people want pollution control.

It can be done. The Ohio Valley is exhibit No. 1. Ed Cleary, Executive Director of the Ohio River Valley Water Sanitation Commission, has proved that public support CAN be aroused, and has demonstrated what can be achieved with public support.

One of the problems in the pollution field, incidentally is to get an organization that can override political boundaries and do an effective regional or watershed job. The same roadblock exists in other fields. Only public demand can overcome the resistance of county, village, city and state officials, jealous of their jurisdiction.

There is no better man, I think to head up or advise a national education program in the pollution field than Mr. Cleary.

It is no coincidence that the *Cincinnati Enquirer*, in the city of his headquarters, has a pollution plank in the platform printed daily under its masthead. Cleary has made a vigorous and successful effort to enlist the press of the Valley.

Neither is it a coincidence that pulp and paper mills in Wisconsin lead the national industry in attacking disposal of waste sulphite liquor, one of the Nation's major pollutants. My paper, the *Milwaukee Journal*, has been marshalling public opinion for the conservation of natural resources for many years and it is now the policy of the State's press, generally. Paper mill waste, in the spotlight of publicity, long since became a public relations problem for the mills.

Sulphite liquor is discharged in enormous quantities. Finding salable byproducts to offset the disposal cost is important. Only 11 of the Nation's 65 sulphite mills are in Wisconsin, but nearly half of the byproducts were produced there last year. And some 30 Wisconsin pulp and paper mills have installed or are installing a German device for sucking air into turbines at dams to add oxygen to the rivers.

These things cost money. Remember that industry, too, has an economic problem, like the taxpayer. Many industrialists have developed a conscience about pollution, but they have to contend with stockholders. Spending for pollution is limited unless it takes on a dollars and cents value. Public demand creates such a value. But optimum spending for pollution control will not exist until there is a national demand, putting pressure on all competitors in an industry.

A national demand will never be created by merely a national program. This thing has got to be attacked vigorously and intelligently at every level, with an organized effort at each level.

Fortunately, pollution control fits into the purposes of many organizations, civic, business, conservation, scientific and technical. All of them must be enlisted, and not just to pass resolutions and make gestures.

The League of Women Voters might make pollution its study of the year, as it did with water. The Federation of Women's Clubs also is actively interested in conservation. Women can be a big, big help in this campaign. They are an increasingly potent force in public affairs; so many able women, their families grown, are eager to devote their time to worthwhile things. And no one can realize better than they how worth while this one is.

Last January I attended a Senate committee hearing on water resource management, and one of the most impressive presentations was by the League of Women Voters' representative, Mrs. Whittemore.

The league has a regular television program in Milwaukee and probably in other cities, ready made for discussing pollution.

The National Wildlife Federation, with an active affiliate in every State, might make pollution the subject of its annual wildlife week. I know how widely its ripples spread. A water booklet that I prepared for the federation has run through two printings of 10,000 copies each.

Pollution could be the theme, or at least a major program topic, of the North American Wildlife Conference and the National Watershed Congress.

Organizations that join in this effort should establish liaison at national and local levels, with each other and with scientific and technical people and public agencies. Joint action committees under aggressive chairmen could be most effective in enlisting cooperation in the communications and industrial fields. Industries already organized to attack pollution should be represented on the national action committee, and industries in each community should be asked to appoint an able man to work with the local committee. Industry can contribute importantly both in employee and public relations campaigns.

Conservation teachers in the Nation's schools might be enlisted through the Conservation Education Association and the Joint Council of Economic Education, which has a conservation and resource use project.

These details, and the use of communications, must be left to a planning and working group. I mention them to round out the proportions of the job and the possibilities.

All media can be helpful, but the essential medium is the press. If you don't get into the papers, you don't get to the mass of people. I am not just being loyal to my profession; every publicist knows this is true. Even that may not be enough; you may have to use the door-to-door method of charity collections.

Somehow, get the newspaper editors actively interested. Don't beg; don't preach; don't get into controversy. Let the editors argue about Federal, State, and local responsibility—and money. Stick to information.

Approach the editors by letter, and not a form letter. Approach them personally by means of local delegations. You might borrow an idea recently tried in the science field. Some leading editors were guests in September at a seminar on science and the news, financed by a grant from the National Science Foundation. Top-rank men like Teller, Sears, and Revelle were speakers. Two Washington editors attended—Mr. Wiggins of the *Post & Times Herald* and Mr. McKelway of the *Star*. This thing can be overdone; editors are busy men, but it is something worth thinking about. Dr. Flemming or Dr. Burney might well have written personal letters to 25–30 leading editors about this Conference.

At any rate, you might be able to get speakers on programs of editorial associations—and pick good, sharp speakers.

By these means, tell the editors how bad things are and how fast they are getting worse. Maybe they know; you can freshen up their knowledge.

Tell them that a lot of modern pollution doesn't stink and people can't see it, so they must be warned, because it is damned well a flood.

Tell them that the old saying about water purifying itself has become a boobytrap—that radioactivity and a lot of chemicals are invulnerable to the bacteria which dispose of organic pollution.

Tell them that you are going to send story material at intervals.

Then send it. Not handouts. No scientific and technical gobbledygook. Use men who know what has a chance to get into a newspaper and what has not. Your stuff will have to compete with a torrent of news and information about world, national, and local affairs. Sludge worms like Khrushchev and Castro make more news than the sewage variety.

But newspapers have daily and Sunday sections that go to press in slack time and there editors might use a well-written article, perhaps illustrated with charts and pictures, about the Public Health Service's river network and the strange pollutant that showed up at New Orleans and was traced all the way to St. Louis.

Or a piece about the large amount of radioactivity that vanishes from river water in a relatively short distance below any nuclear plant, and the efforts being made below Oak Ridge to find out where the radionuclides go in the plant and animal community.

If such stories are to be acceptable to editors, there is a condition that needs a remedy.

A good deal of information about pollution is uninteresting, even pointless to ordinary persons, unless interpreted in terms that give it meaning. But people in public agencies do not always feel free to do such interpreting.

For instance, the river network showed much greater quantities of beneficial algae in the Ohio River during the steel strike than before and after, a significant indication of water quality. But Public Health Service personnel did not feel free to publicize the obvious inference.

And the fact that several State and Federal agencies were cosponsoring a comprehensive stream study below Oak Ridge was announced in a news story without any explanation that would make it interesting to the public. The story did not tell how concerned some biologists are about the uptake of radioactivity from water by plants and animals.

You cannot treat people like children, deny them the significant facts in understandable form, and then complain that they lack "public awareness and citizen responsibility."

A republic or a democracy cannot function successfully without an informed people.

I have found this wariness of Federal and State people in all agencies dealing with natural resources, and I think it is one of the barriers to good resource management. Most of us know the reasons for it. Informed men must be encouraged to speak their minds. Scientific men must learn not to quibble, as physicians have learned, who give medical testimony before juries. Ifs, ands and buts are not convincing.

Getting back to editors and their space problems, I can tell you that any topic may suddenly become important. Any organization that may grow out of this Conference should be alert for such opportunities and set up to make effective use of them.

When dead fish are floating on a river or lake, when ducks are trapped in oil or dying of botulism, when algae stink, when floods have left filth in basements and streets, when septic tanks drain into ditches, when people are angry and the news is on the front page—then is the time to get the whole story told, or as much as possible.

I keep a file of resource material. When something in the news focuses attention on some problem, I dig into the file. After local pollution troubles hit the front page, I wrote two columns about the national situation and the editor was glad to get the article for feature play the following Sunday.

So, when a local or State pollution situation gets into the news, regional public health people or your local citizen groups should quickly inform the information headquarters. And while the local interest still exists, local editors should be sent material with the suggestion that their readers may be interested in related problems all over the Nation.

The dollar consciousness of the public might be turned to account. People should be told how much any delay in tackling pollution may cost them. According to the *Engineering News Record* index, construction costs went up 240 percent from 1940 to 1960; 62 percent since 1950. In the case of treatment plants, the rise was partly offset by improved designing, but that does not apply to sewers and outfalls.

And if you think that many communities are not still in the septic tank era, take a look at the proportion of sewer systems and interceptors in the PHS summary of construction awards.

The volume of wastes increases, too, and more plants must be built at the higher cost. And it is not just the cost increase; a bond issue may double the apparent cost. Many a community which could afford to add to a plant, if one had been built years ago, finds itself unable—or is unwilling—to build the whole plant now.

Delay results in a vicious spiral, which should be explained to the people. Wartime and postwar priorities prevented construction. Even States with aggressive programs have been hard pressed to overcome this handicap and keep pace with the increasing load.

Wisconsin has had a good law and a good organization for years. In a quarter century, the treatment of organic pollution tripled. At the end of the period, almost as much was being eliminated as the total potential load that existed at the start; but so much more polluting material was being discharged into the State's waters that the net reduction was only 7 percent. I speak in terms of pounds of biochemical oxygen demand. This does not consider the tremendous new load of detergents and other chemicals, etc., that do not yield to biological disposal.

If this is true in a State with a good program, what must be the condition where the attack on pollution began late, or is just getting started?

Delay also can impose an insurmountable handicap. Milwaukee's flood problem is an example. In common with all old urban areas, Milwaukee has sewers which take both sewage and storm runoff. With the development of treatment, cities learned to provide separate sewers. Still later they became aware that foundation drainage should be kept out of sanitary sewers.

The dual-purpose sewers can be replaced, although it is a long, expensive job; but it is practically impossible to change the connection of house drains from sanitary to storm sewers.

Two results of this loading of storm water into sanitary sewers are (1) that sewers back up into basements in time of heavy rains, do much damage, and leave a lot of filth which can create health hazards; and (2) that a torrent of storm water, which needs no treatment, overburdens sewage plants. After a continued wet period, it can amount to as much as one-third of the total volume. An efficient activated sludge plant, which can remove upward of 90 percent of the bacteria and solids under ordinary conditions, may remove only 60 percent at such a time.

Building code changes to prevent aggravation of this problem should not be delayed; but in how many communities do the people understand this?

These comments may seem to be digressions from my theme, but they are offered with a purpose. I think that examples of this sort might be used effectively in an information program. Many persons are more impressed by specific things than by generalities. Subjectiveness again—the specific things might happen to them.

It seems to me that the lively public interest in water supplies creates a wonderful opportunity. Much more effort should be made to emphasize the important role of pollution control and prevention.

There is grandeur about big dams. People can look at them and use the reservoirs for recreation, and feel the satisfaction of achievement.

The idea of getting fresh water from the sea captures the imagination.

Sewers, however, are buried in the ground. There is nothing grand about a sewage treatment plant and no boating or swimming in a stabilization pond.

But the treatment of sewage can mean a great deal more in the way of usable water to a great many more people than reservoirs or saline water conversion. I think that every effort should be made to help people understand this.

They should know that a water supply near at hand is infinitely more important and valuable than one at a distance. They should know how much it costs to store water and to move it, unless it is going downhill. These costs already have placed irrigation in the West beyond the financial reach of landowners, unless users of electricity and the general public carry part of the load.

Saline water has not yet been converted for as little as $1 per 1,000 gallons, and the boldest hopes are for a cost around 40 cents. The Milwaukee sewage plant restores water from sewers to better than 90 percent purity at a cost of 4 cents for 1,000 gallons. And the very distillation processes used to convert salt water could be used much cheaper to restore contaminated water to absolute purity.

Some problems have dramatic or picturesque aspects that lend themselves to publicity gimmicks. The smoking debris of a forest makes an impressive backdrop for Smokey Bear and his slogans. Perhaps a stretch of filthy stream, with floating garbage and dead fish, might be used as a background for a picket line of magnified bacteria, bearing signs with such legends as—

"Unfair to organized organisms";
"We demand more oxygen"; or
"Down with the 24-hour working day."

The forest fire, of course, recalls latent memories of great losses of human life and property, as at Peshtigo, Wis. If the people killed on the highways were dying of poisonous drinking water, this meeting would not be necessary.

As it is, the task of arousing a public demand for pollution prevention and cure is stupendous. Just thinking about it can be frustrating.

So, let's not think about it; let's get at it!

We are very late.

## DISCUSSION

### Mrs. Arthur E. Whittemore

***Chairman, Water Resources Committee and Director, League of Women Voters of the United States***

After the lively and practical presentation we have just heard, it is obvious we should be well on the way to solving pollution if we had a Mr. Lynch on every newspaper and a Mr. Cleary in every river basin.

Unfortunately this is not the case. I should like to pick up three of Mr. Lynch's points and discuss them from the point of view of the citizen organization: How it can join with the experts, the Government agencies, and the mass media so that all can be more effective. The three points are facts in usable form, joint action committees, and the regional attack.

But, first, another tribute to the word "stink." The League of Women Voters of Beaumont, Tex., found it effective some years ago when they were unable to get the community aroused about a particularly bad sewage disposal problem. In desperation they adopted the slogan "Beaumont is beautiful, but it stinks." This shock treatment worked.

To do this type of thing in a community, there usually has to be some citizen group, as there was in Beaumont. It seems to be the rare person who feels he knows enough about a subject like pollution and feels strongly enough about it to act under his own steam. Most of us do better working along with others in some organization. You will understand that I draw my illustrations from the organization with which I am most familiar, but men's service clubs, women's clubs, PTA's, garden clubs, and many others could report similar experiences.

The first task of such a group is to get the facts, local ones and related regional and national ones. There is available a terrific amount of information, but just try to find it. Sometimes it is in scientific jargon in small print surrounded by figures and charts. Sometimes it's in some agency's files or heads; or embedded in a book resulting from a research project, full of formulae each taking an entire page. I hasten to say that occasionally a State or Federal agency, or a compact commission, puts out interesting and effective reports. But even this does not remove the need to round out the facts from other sources, and get them into simple form for average citizen use.

Once the facts are assembled, the next job is to get them out to the public in such a way as to stimulate action. Here is where I think the citizen group is extremely important. Even more effective is the joint action committee, including a number of organizations.

Let me give you an illustration: the recent action taken in Kansas City, Mo. By September 1959 nothing had been done by the city to clean up serious pollution, in spite of Federal and State efforts to get it to do so. Then the Missouri Water Pollution Board placed restrictions on sanitary sewer extensions and the Veterans Housing Administration threatened to cut off loans.

About this time effective group action began. Several organizations participated from the start, but my knowledge comes from the report sent in by the Kansas City League of Women Voters. Their November bulletin reporting on the climax of a year's effort says—

> We worked and worked for the sewer bonds. We spent October 12, 13, and 14 telephoning from a room in the Plaza provided by the Chamber of Commerce. Forty-two of us kept nine phones busy from 9 to 4:30 each day. We got in touch with over 500 organizations, took orders for thousands of pieces of literature, placed about 30 speakers, and secured endorsement by many groups.

An excellent three-page question-and-answer piece was put out by the League early in the campaign with down-to-earth information about Kansas City water costs compared to other cities and what would happen if the bond issue failed to pass. They also issued in large quantities a flyer, "You are Guilty . . . You are Guilty of Pollution."

The *Kansas City Star* reported that toward the end there were 64 organizations supporting the bond issue. Among them were the Chamber of Commerce, the AFL-CIO, many women's groups, service clubs, the Jackson County Medical Society, church groups, the Conservation Council, the Regional Health and Welfare Council, and the Home Builders of Greater Kansas City.

The newspapers and other media gave full support. The papers used much ingenuity in keeping interest aroused. They not only reported facts; they gave editorial support. On November 3 the *Kansas City Star* declared: "The only thing this community could get from delay is a bad reputation for fighting to keep a public health menace." It continued: "There can be no question that the Federal Government is committed to end pollution on the major rivers. It is a proper responsibility of Federal Government."

There was an article by the real estate editor entitled "Key to City's Growth Is New Sewers," and one appealing to oldtimers in the community entitled "The River—Key to Kansas City's Past and Future." Meantime there were a number of supporting television programs.

When it was all over and the bond issue had been passed by a good margin, the paper paid tribute to the citizens, saying: "Viewed by cynics as the amazing feature of the antipollution vote is the fact that the voters balloted in favor of an average of a 48 percent increase in their water bills."

I have gone into this in detail because it so well illustrates the needed ingredients of a successful campaign. First someone to get it started, hard work by a lot of people, effective use of facts by organizations and the newspapers, and the cumulative building of community understanding and support.

Hard as it is to get through a bond issue for sewage treatment, in many ways this is easier to tackle than a problem which needs solution on a regional level. The government, the newspapers, and the national organizations are not set up to match a region or a river basin. Yet, as Mr. Lynch has pointed out, much of the pollution problem must be solved regionally.

We have found that equipping our members with a set of questions starting with their local water supply and sewage disposal, and ending with a whole drainage area, was a good way to get our members together across State boundaries. We have had groups operating in the Columbia River Basin, the Potomac, the Delaware, and more recently in the Ohio, Missouri, and Colorado—as well as in many small basins.

The significant result has been that women who had been really alarmed that "upstream" would put something over on "downstream," or urban on rural and so on, found they were able to agree on relevant facts and on possible solutions. We are interested to see if the techniques we have found so successful within our own group can now be used to set up regional citizen committees with the same broad base that Mr. Lynch described for the local or national joint action committee with representatives from organizations, industries, universities, government agencies, press, and so on. Their task would be to assemble, supplement, and put in usable form the mass of information already available, and apply it to the solution of a regional problem like pollution.

A big step is being taken at this meeting. We shall leave it with information and impetus. How can we use the findings? Do they give the press the needed springboard? Can they be put in a form that will reach the average citizen? How can organizations make best use of them with their members?

Are interested agencies like ORSANCO the ones to set up regional meetings? What of the places where there is no aggressive pollution control agency? In such a region should citizen groups take the initiative?

Not all these questions can be answered by one conference. I hope that our discussion will have given us a good start. It is up to us now to create public demand for programs which will result in clean water in every part of the country.

## DISCUSSION

### David B. Lee

***Director, Bureau of Sanitary Engineering***
***Florida State Board of Health, Jacksonville, Fla.***

Mr. Chairman, ladies and gentlemen, it is an honor to have the privilege of discussing the paper of Mr. Lynch and it would be very simple to open and close my remarks by saying I agree wholeheartedly with the context of his paper, then sit down. It has always been a difficult problem for me to ascertain the direction a discussant should take, whether to compliment and agree, expand or criticize, but this paper has no criticism due it, unless one could say that time did not permit Mr. Lynch to hit all the facets of this important subject. So with his permission and your tolerance, I am merely going to expand briefly on some of the points as we observe them.

Mr. Lynch has taken the title of this talk and made two subjects out of it. I agree that most people are aware of the pollution problem whether they appreciate the seriousness of it or merely know it exists, is hard to determine. We personally feel that citizens' responsibility is something that should be heavily emphasized. I had the unhappy experience recently to talk to a professor of sanitary engineering who was opposed to an annexation issue because it would cost him money, although his septic tank, which does not function because of the location of his home, has a relief pipe into a storm drain thus dumping raw sewage into an open waterway; yet he is a good professor of sanitary engineering technology. This is not alone the feeling of one individual; it is true in much of our citizenry. There have been bond issues voted down in areas about which I am familiar where the people were unable to use their sanitary facilities for as long as 4 to 6 weeks due to flooding. Of course, on the other side of the ledger, there are many towns who have carried their bond issues through organized public awareness with the emphasis on citizens' responsibility.

While we are discussing public awareness and citizens' responsibilities, I think one of the greatest needs in addition to the newspaper, radio, and television people to spread the word is to get the Chambers of Commerce, the committees of 100 and the energetic promoters of our communities, cities and States to actively get behind this type of activity. These are groups as a whole which I frankly feel, impede our progress more than they help.

As mentioned above, we are failing to convince the citizens who resist because of their fear of higher taxes that this resistance is the most expensive form of taxation. Many are not familiar with the continual climbing of costs and have absolutely no appreciation or vision of the importance and liability of degradation of our water resources due to pollution now and in the future. They are more interested in the cost of today than the added cost of tomorrow and they are sort of like the old blind mule I used to plow. Then, again, we are faced with the promoters of industry with its waste products, who feel that if the regulatory people mention pollution and pollution prevention and abatement, they will not be able to land the industry, thus progress will be impeded. It is nothing new to inform people, communities, and organizations of what will happen if this or that is permitted and later when it smells, looks bad, creates a serious pollution problem, etc., the same people will then jump on the regulatory people for allowing them to allow it to happen. Then, in many instances, it is rather difficult to correct, and no answer is available.

While this appears to be a negative paper, it is not intended to be, but I wish to point up some of the weaknesses which are now obvious in this activity. We discuss public awareness and citizens' responsibility. At the same time I think we should make a serious effort to get professional awareness and professional responsibility. It is true that we talk to ourselves too much but until we get our professional people informed and agreeable in the philosophy of preventing and abating pollution, we will continue not only to have responsible public officials but the people confused. For example, recently an engineer, registered under the laws of his State, made the headline in the local press by stating, "While the town now has an estimated 16,000 people and the Chamber of Commerce estimates 80,000 by 1970, the town would still not need sewers in 1970." It is my recommendation that serious effort be made to bring our professional people into a "togetherness." This includes health officers, medical officers, engineers, chemists, biologists, attorneys, and all people in the environmental health discipline as well as in the water resource field.

Public awareness and citizens' responsibility play another major role in developing better planning, better zoning and better regulations which will, in our opinion, provide an excellent tool in the prevention and abatement of pollution, but the zoning must have political muscle and not be for special interests.

Mr. Lynch mentioned that he had found wariness in Federal and State people dealing with natural resources and that he felt that this was one of the barriers to the good resource management.

"Informed men must be encouraged to speak their minds. Scientific men must learn not to quibble, as physicians have learned, who give medical testimony before juries." As a State official, I feel that we do speak out and it takes a lot of fiber in controversial issues to do this because just as surely as one does, he is immediately tagged with the title of bureaucrat, empire builder, didactic regulator, etc. Then, too, there are many who are willing and have the know-how to speak up but are under a tent and are hindered from making this approach.

We have the information and do furnish it to the editors when asked (and many when not asked); also to organizations and will continue to do so. It is our feeling that if the public, and this is everyone, will become an apostle of those who are familiar with this problem, it will be only a short time until our political leaders and taxpayers will support this program.

In closing, I want to reemphasize that in addition to the basic public, we need to bring together the professional people in a common awareness of this creeping corruption and remember that "the solution to pollution is not dilution."

# Financing Aspects of Water Pollution Control[1]

FRANK E. CURLEY

***Partner, Hawkins, Delafield & Wood, New York City***

In his message to Congress on February 23, 1960, announcing that he had requested Secretary Flemming to arrange this first federally sponsored National Conference on Water Pollution, President Eisenhower expressed the hope that it would "help local taxpayers and business concerns to realize the obligation they have to help prevent pollution." Even the most casual student of public-office semantics could not have failed to detect the significance in the President's choice of words. In the times in which we are living, a public reference by any official to us as "taxpayers" usually has ominous overtones. But when the President of the United States refers in one and the same breath to both the "taxpayers" and their "obligation," there can be no doubt whatever that what he is saying is "How (and when) are they going to pay the bill?"

It is altogether appropriate that the President's message should have underscored the urgency for finding a reasonable, sound, and effective method, or combination of methods, for financing the Nation's water pollution control program. Never has the need seemed greater. The increase in population and industrial production in the United States over the past 50 years has increased the volume of municipal wastes in our waterways more than 200 percent and industrial pollution has risen 2,900 percent. The U.S. Public Health Service has estimated that in order to dispose of the present load of municipal sewage being dumped into the Nation's waterways, 4,000 new sewage treatment plants should be constructed at the present time and an additional 1,700 plants modernized. It is estimated that the cost of construction and reconstruction required right now—the amount which has to be financed from one source or another—is $1.9 billion. This is only the amount necessary to eliminate the present backlog. In order to catch up with treatment needs by 1968, an additional estimated $1.8 billion is necessary to provide for population growth and $900 million to replace obsolete plants, a total of $4.6 billion over the next few years for municipal waste treatment alone. Industrial waste treatment is estimated to require more than 6,000 new projects costing about $2 billion, including in-plant changes. With some estimates of our population as high as 235 million by 1975, long-range planning over a period of 15 or 20 years is essential in order to meet the rising costs of the projects. The cost will obviously remain high so long as we are trying to catch up with our requirements.

---

[1] Paper was read by Senator Whitfield.

In a summary of physical facilities data based on the 1957 Inventory of Sewage and Industrial Wastes Facilities, the Public Health Service reported that there were more than 3,000 separate raw discharge facilities serving nearly 22 million persons. Of these facilities, 93 percent, serving 85 percent of the population covered by the survey, required new plants. Thirty-three States reported that over 95 percent of the facilities discharging raw sewage required new treatment plants. Over 5,400 communities serving 48 million persons were reported by the inventory to be discharging raw or inadequately treated wastes into the Nation's waters.

It is significant, in considering the financing aspects of water pollution control, to note that nearly nine-tenths of these communities were towns of less than 10,000 population, with most of the balance having populations ranging from 10,000 to 50,000 each. This is not to suggest that the large cities have solved their water pollution problems or that their contribution to the Nation's polluted waterways is not impressive. One-half of the 150 larger cities having a population in excess of 50,000 still discharge raw sewage with respect to some 12 million people. But it is still the small community which faces the most difficult problems in finding a way to comply with the regulatory orders from the State capital and still survive financially. It is often the case that the cost of meeting these needs imposes a greater financial burden upon the taxpayers of the small town than upon their city cousins. Recent figures of the Public Health Service indicate that the annual per capita cost of constructing a treatment plant for a town of 10,000 may be twice that for a city of 100,000; a taxpayer in a town of 1,000 population may pay 3½ times as much as the city resident. The annual per capita cost of operation and maintenance follows a similar pattern. In addition, the small town, because of credit ratings, bond market conditions, a more limited market, and related factors, may be obliged to pay more for borrowed money than the larger city; the cost may be so exorbitant that it cannot even enter the market.

This brings us to the ways presently open to a community for financing its water treatment facilities. It is the declared policy of the Congress, as set forth in the Federal Water Pollution Control Act of 1956, that the prevention and control of water pollution is the primary responsibility and right of the States. Therefore, in examining the various methods of financing these facilities, we commence at the local level, where the responsibility is declared to rest. One problem immediately becomes apparent. In addition to the financial burden which the taxpayer of the community may be obliged to assume, he may discover that he—and indeed perhaps his entire community—will derive no visible benefit from this expenditure. Rather, by building an expensive water treatment plant in his town and refraining from unloading his raw sewage in the river, he finds that his taxes are making life pleasanter and more healthful only for the town downstream. This is not a new tax for school building on the next block to which he can send his children; it is not for paving a street on which he can ride. This new tax burden may be, in effect, to make the river cleaner for taxpayers in the next town who are not being asked to contribute a dime to the cost of the facility. Lethargy, if not outright hostility, soon sets in.

His municipality, however, may be required to abate the pollution, whatever the cost. The water pollution control legislation of many States expressly empowers the State regulatory board or commission, after classifying the waterways, to issue orders to offending municipalities to cease contaminating the river or stream. The Federal act has similar provisions. Failure to comply with such an order can result in court action. A claim by the municipality that it is unable to raise the money to pay the cost of the new facility will probably be of little avail unless the State statute contemplates such a defense. In a recent leading case in New York, *Matter of Town of Waterford et al.* v. *Water Pollution Control Board* (5 N.Y. (2d) 171 (1959)), the court of appeals held valid a classification of the Mohawk River by the State water pollution control board which may eventually require the Town of Waterford to construct a new sewage treatment facility, notwithstanding the town's protest that it "would be forced to levy a 150 percent increase in taxes and be required to forego all other civic improvements for at least a generation." The court dismissed this argument with the statement that it "is another way of saying that a physician may not diagnose a serious disease as such if the patient cannot afford the cost of cure." In the court's opinion,

> * * * the legislature well knew that a comprehensive water purification program would impose a financial burden upon the municipalities of the State, but deter-

mined, by enacting the Pollution Control Act, that the pressing need for water purification outweighed any financial hardships incident thereto.

The result is the same when a municipality submits a proposition on a sewerage bond issue to its citizens and they reject it, notwithstanding the order of the regulatory board to cease its pollution. This has happened in several cases recently. One small town here in the East has held five referenda in the past year and a half on a proposition to build a sewage treatment plant costing $600,000; four of the referenda were defeated by the voters and one was passed with a maximum interest rate that made the bonds unmarketable. The voters of St. Joseph, Mo., have twice defeated bond issue propositions to construct waste treatment facilities, and on September 29, 1960, the Federal Government filed a suit against the city to force compliance with a pollution cleanup order issued under the Federal Water Pollution Control Act of 1956. In spite of voter resistance, the problem still remains for the community—how can the project be financed?

The obligations which a municipality might issue to finance a sewerage plant can be general obligations—that is, backed by a pledge of the full faith and credit of the municipality—or (when permitted by local law) by revenue bonds, secured by a pledge of sewer revenues or rentals—or a combination of both.

The voter's resistance to a new tax levy to pay debt service on his town's bonds is frequently weakened or overcome by an offer of Federal or State aid or through joint action with other communities in the area. The Federal Water Pollution Control Act of 1956 provides, among other things, for grants to States and interstate agencies to assist them in meeting the costs of establishing and maintaining adequate measures for the prevention and control of water pollution. Allotments are made to the States on the basis of population, extent of the water pollution problem, and financial need. In addition, the Surgeon General is authorized to make grants to a State, municipality or intermunicipal or interstate agency for the construction of sewage treatment works, after approval of the project by the State control agency, in an amount not exceeding 30 percent of the estimated cost of the project or $250,000, whichever is smaller. At least 50 percent of the appropriated funds for each fiscal year are required to be used for grants for the construction of treatment works servicing municipalities of 125,000 population or less. Since the enactment of the Federal Water Pollution Control Act, the Congress has appropriated a total of $232.5 million in Federal aid to communities for the construction of necessary sewage treatment works. Over 2,300 projects have been approved to date, involving a total construction cost of $1,120 million. The Federal grants-in-aid approved for these projects amounted to $193.5 million, or 17 percent of the total estimated cost of construction.

Another method of spreading the financial burden among a larger number of taxpayers and at the same time perhaps effecting economies in the construction and operation of sewerage facilities is the creation of a regional district or authority. The district may be within a town, which will construct and finance the system and charge the cost in the form of sewer or water charges or assessments to the residents of the district benefited thereby. The district may be countywide, embracing a number of communities, each of which contributes to the cost of constructing and operating the project. Subject to local law, such a district may have both taxing powers and the power to issue revenue bonds secured by sewer or water charges and rentals. Two or more communities may, if authorized by local law, join forces in the financing, construction and operation of sewage treatment and disposal facilities. In 1956, the New York State Constitution was amended to permit such joint action by two or more municipalities, including the power to contract joint indebtedness or to contract indebtedness for specific proportions of the cost. The sanitation districts of Los Angeles County, Calif., have been effective partly because of their ability to join with other districts in the ownership, construction, and operation of joint facilities.

In New Jersey, a general law authorizes the creation by counties and municipalities of sewerage authorities, including authorities established jointly by two or more municipalities. Several of these authorities, such as the Middlesex County Sewerage Authority, have successfully financed projects through the issuance of revenue bonds secured by contracts with municipalities using the facilities. In the case of the Somerset-Raritan Valley Sewerage Authority, three relatively small municipalities, each operating its own collection system, have been able, by means of a sewerage authority, to construct and operate a trunk sewer and treatment plant serving all three communities at a cost considerably lower than the combined cost if each had been compelled to build its own plant. New Jersey also permits two or more municipalities to create joint municipal utilities authorities having the power both to provide and distribute an adequate supply of water to the participating municipalities and to provide sewage collection and disposal service. By combining not only the resources and operations of the participating municipalities but also the revenues from both their water and sewerage systems, the joint authority may afford substantially better prospects for a successful financing than would the participating municipalities acting alone.

Regional public authorities may also provide a means of financing the cost of constructing and operating facilities which a local community may be unable or unwilling to undertake. Such an authority is an independent public corporation whose members are usually appointed by the Governor, the mayor, or the governing bodies of the participating governmental units; it has the power to finance the construction of sewerage facilities by the issuance of its revenue bonds secured by sewer or water rents and charges; it has the power to establish and collect sewer rents but usually not to levy taxes; its bonded indebtedness is not the debt of the State creating the authority and is usually not subject to the debt limitations applicable to the State or its political subdivisions. One further development of the public authority concept might be an interstate compact agency with power to construct and operate facilities to prevent pollution in waters adjacent to cities of two or more participating States. Such an authority, created by legislation of the participating States with the consent of the Congress, might have much the form and powers of a regional public authority. Joint participation at the present time by various States in interstate commissions relating to water pollution control is illustrated by the Interstate Sanitation Commission, the Interstate Commission on Delaware River Basin, and similar cooperative agencies.

The financing of sewerage facilities can be facilitated at the local level by a careful review and strengthening of applicable statutes. Constitutional or statutory restrictions which unduly inhibit the expansion of treatment and disposal facilities by municipalities should be reexamined. As the result of extensive studies by a special legislative committee several years ago, the New York Constitution was amended to permit a municipality, in ascertaining its debt incurring power, to exclude certain indebtedness incurred in financing wholly or partially self-sustaining improvements. At the same time, State legislation relating to the fixing and collection of sewer rentals was made more workable. Frequently existing legislation may be found to be incomplete, inconsistent, or vague. It is important to maintain a maximum of flexibility for the various units in the bases of charging for the construction, maintenance and operation, and debt service of sewer systems and disposal plants and, at the same time, maintain uniformity in sewer rental provisions. Existing laws should be reviewed with respect to clarifying the meaning and extent of sewer rents, and defining the entire principle of sewer rent usage in a workable manner.

In addition, attention should be given to the encouragement of private industry, through tax benefits and other concessions, to eliminate or at least provide adequate means for their own waste disposal. Many companies are meeting this problem today with a sense of responsibility, frequently in close cooperation with the municipality. In other areas, the matter is often still regarded by the business executive as a responsibility of the town, in the same category as the furnishing of adequate streets and police protection.

This discussion of proposed alternatives of financing these projects has stressed the responsibility of the States and their subdivisions to take the initiative in solving the problem. This is as it should be; the congressional declaration of intent is clear. Every effort should be made to finance the facility out of local funds or on the strength of local credit. But if that proves not to be sufficient, it will not do to remain idle in the face of a continuing and increasing health and social hazard wrought by the pollution of the Nation's waterways. More effective methods of financing the construction of needed sewage projects at a national level should be explored and developed if and to the extent that the State and its municipalities are unable to undertake the financing.

It might be appropriate, for example, to compare the method by which low rent housing has been financed on a large scale during recent years. Following World War II the demand for low rent housing was critical and private enterprise was unable to supply that demand at a fair return. A solution was worked out between the States and the Federal Government under which State—or municipally created public housing authorities issued bonds secured both by the revenues from the housing project being financed and by an agreement with the Federal Government to contribute amounts annually to the authority sufficient and necessary to meet any deficiency in the debt service on its bonds. This arrangement leaves the construction and operation of the project in the hands of the local authority; the financing is also by the local authority, through the public sale of its revenue bonds, supported by the contractual commitment of the United States. There is nothing that compels a State or municipality to participate in the program; if the needed housing can be financed without Federal assistance, either by private enterprise or with State aid, it is free to go its own way.

Water pollution which affects the health and well-being of the Nation's citizens may justify Federal participation with local units in somewhat the same manner and to the same degree as low rent housing. If a State and its municipalities, with the cooperation of industry, can effectively protect their citizens from the hazards of water pollution without Federal assistance beyond that afforded under the present law, they should proceed with their own program as promptly as possible. But for those States and communities which are faced with the dilemma of an urgent need to eliminate a pollution hazard and are unable to undertake the project alone or in concert with similarly affected communities, careful thought might be given to the development of a possible financing procedure similar to that presently being used in connection with low rent housing. The machinery for such a procedure—whether the program should be administered through the Public Health Service or some other agency—can be determined after the soundness of the procedure itself has been carefully tested.

As indicated in the President's message to Congress, the question of financing the huge water pollution control program is of prime importance. All of the technological advances and scientific knowledge in this field during recent years, all of the thought and hard work devoted to it by so many dedicated citizens, are of little avail without the means of raising the hard cash necessary to put that knowledge and advancement to work. It is not enough to develop new and effective scientific methods if we cannot or will not exert the imagination and energy required to put those methods to work. The existing means of financing the water pollution control program should be most carefully examined and tested, and if those means are found workable in any situation they should most certainly be utilized. But if, for any reason, they are found wanting, and the health and necessities of the public demand prompt and effective action, then new ways to finance the projects must be constantly explored and developed. Only when we can find the way effectively to apply our scientific knowledge and advancement in the field of water pollution control and make it productive can we really take credit for that advancement.

## DISCUSSION

### ROBERT F. BOGER

***Publisher, Engineering News-Record, New York, N.Y.***

Mr. Curley's remarks are worthy of serious study, for he has covered his subject very thoroughly and very competently. In fact, he leaves little room for comment.

Much of the work of this Conference is devoted to measuring our water pollution problem, both in terms of its size—that is, its magnitude—and its urgency. I think it is safe to assume that the consensus of this group will show that the need is very large and the urgency is very great—just as Mr. Curley has stated.

Chances are, however, that political and economic realities will force us to accept a minimal solution to our problem for the moment; this, in spite of abundant evidence that present population and pollution trends, if continued, are bound to produce an intolerable situation—a situation that may require drastic action.

Mr. Curley has pointed out quite clearly that one of the major obstacles to the problem of financing facilities for abating pollution is the public's reluctance to accept the cost of such facilities and their operation as an obligation, in the same way that the average citizen accepts the cost of other services and utilities as a necessary part of his living expenses. I think there has been substantial progress made in educating the public in this respect, and I think great progress has been made in mobilizing public opinion to take such affirmative action as approving bond issues to finance the construction of pollution control facilities. The Missouri River situation, which Mr. Curley mentioned, will be greatly relieved by the recent bond issues in the two Kansas Citys.

But, this progress is not yet success. One thing we might do to hasten the public's acceptance of its responsibility in this area—and, at the same time, help solve the financing problem—would be to require communities and industries to provide for the treatment and the disposal of their waste water at the same time they plan for their water supply. In other words, instead of planning systems that merely supply water, communities and industries would be required to plan and finance systems that also treat and dispose of the water after they have used it. The city of Cleveland took a step in this direction a few years ago when it banned new water services to suburban developments not also served by sewerage systems and treatment works. This caused a lot of comment at the time, but builders and owners were quick to fall in line, and the city of Cleveland took a large step forward in curtailing the pollution of Lake Erie, which, as you know, is the city's water supply.

In our society our water supply systems and our waste disposal facilities have evolved as separate entities. Perhaps it is only natural that they should have, for disposal was once solely a matter of conveying wastes to the nearest stream. From this practice comes that well-known maxim,"Dilution is the solution to pollution." No longer is the answer to our problem as simple as this bit of doggerel. We must now consider this pollution problem as an integral part of our water supply problem.

Whenever we plan a water supply system, we should also plan facilities for treating the water after we have used it. The whole business should be planned and financed at the same time. When we create a water supply system, we create the problem of disposing of the water. This is the time then to finance the pollution abatement facilities.

Naturally, this will not solve the problems that already exist in our many communities. But, it will help greatly to curb the further enlargement of our existing problems.

As I have already tried to point out, public information can do—in fact, is already doing—a great deal to educate the public to the necessity of spending more money to treat their communities' wastes. Our citizens want to act responsibly when their communities face these decisions, and I believe that helpful information on the subject of pollution control is welcome. But, there is need for something more than public information.

The problem as it now exists is a staggering one, and powerful stimulants will be required if we are to realize any substantial gains in reducing the pollution load which our streams are now carrying. The problem is so widespread and so complex that I believe this stimulation must come from the Federal Government.

The Federal Water Pollution Control Act of 1956 was a fine step in this direction. The Public Health Service deserves the greatest commendation for the successful manner in which they have administered this law. Successful as it has been, though, it is not enough; and I believe the Public Health Service would agree with this statement.

If the Federal Government, as I have suggested, is to play a larger role in this field, then I am sure we must find a better way of financing their participation than was proposed in House bill 3610 which President Eisenhower vetoed last February. In some respects, this is reminiscent of experiences we had with the Federal Highway Act of 1956, under which the Federal Government is now paying 90 percent of the cost of our Interstate Highway System.

I am not suggesting or implying that the Federal Government should participate in water pollution control to the same extent, or in the same ratios, as in the highways program. I am suggesting—and I believe it most sincerely—that the Federal Government must provide the powerful stimulant I mentioned previously if we are to make any substantial progress in dealing with the pollution problem as it presently exists.

As many of you know, the enactment of the Federal Highway Act of 1956 turned on the creation of the Highway Trust Fund and the earmarking of specific taxes for this specific purpose—no diversions to the general fund were permitted.

I believe that the creation of a similar fund, from similarly earmarked taxes, is worthy of the most thoughtful consideration. To this end, and in all humility, I suggest these as possible tax sources (I am sure there are others):

1. Just as the Federal Government taxes our telephone bills, let us consider the possibility of taxing water utility bills.
2. Let us consider the feasibility of a Federal license tag for all waterborne craft now using our surface waters either for business or pleasure. This is especially intended to include small pleasure craft, not only as a tax source, but also as a means of uniform law enforcement.
3. Federal gasoline and other fuel taxes, as imposed on and collected from motor vehicles, be collected from the sale of such fuels as are used by waterborne craft.

At this point my references to the Federal highway program seem meaningless, for I am sure, as I know you are, that the sum total of all such levies would amount to but a tiny fraction of the tax sums collected from highway users. Nevertheless, the tax sources I have suggested could yield many more dollars than are presently being appropriated by our Federal Government for pollution control purposes. A most important point I wish to stress here is that such taxes be clearly and irrevocably earmarked for pollution control purposes. Of equal importance is the need for the Federal Government to leave to local government the job of eliminating their pollution hazards.

Certainly there is nothing new about the Federal Government lending financial aid to local communities for local needs. I suspect that everyone within the hearing of my voice can think of one or more examples. Nobody wants more Federal bureaucracy. Neither does anybody want to see the Federal Government take over any more of the local government's responsibilities. If this problem were strictly a local one, as claimed by some, then it might be reasonable to expect local government to come up with the solution. It is true that the problem is frequently a local one, but it is not always a local one. Moreover, some of these situations are so complex that no reasonable combination of local and/or regional authorities could handle them.

In conclusion, I am inclined to believe that if the Federal Government does not provide the stimulus and the push for correcting our pollution situation, then we are left with the world's greatest buck-passing game of the pot calling the kettle black—of each community claiming its neighbor is to blame.

# Legal Aspects of Water Pollution Control

CHESTER S. WILSON
***Stillwater, Minnesota***

## I. GENERAL OBSERVATIONS

### *Appreciation*

First, let me express my thanks for the help I have had in gathering both information and ideas for this paper from Mr. Murray Stein, Chief of the Enforcement Branch of the Division of Water Supply and Pollution Control of the U.S. Public Health Service, and his staff, as well as from all the State administrators and legal counsel who have answered our questionnaire. This cooperation manifests a healthy and widespread interest in the subject matter.

### *Scope of discussion—State laws relating to public interests*

Every phase of the far-reaching enterprise of pollution control is necessarily governed by law. Hence it is important not only for legal counsel but for members of governing bodies, administrators, technicians, and others who are engaged in pollution control work or who are affected thereby to have at least a working knowledge of the principal provisions of laws to which they are subject.

Because of time limits, this paper will deal only with State laws on pollution control, under which the major part of the work is done throughout the country. The Federal Water Pollution Control Act and the laws governing interstate compacts are also highly important within their respective spheres, and they will no doubt get due attention elsewhere. However, we do not have time to go into them here.

The State laws relating to pollution control fall into two general categories:

(1) The laws governing public interests and operations;
(2) The laws governing private rights and obligations.

### *Significance of laws governing private interests*

Since time is limited and since the main purpose of this Conference is the advancement of the public water pollution control program, we shall deal mainly with the laws in the first or public category. However, attention should be called to some aspects of the private pollution laws which have an important bearing on the public program.

### *Public program aided by private action*

All who are concerned with public pollution control activities should be mindful of the laws relating to private interests involving pollution and with actual problems arising in that respect within their jurisdictions. The reason is that legal action taken by private interests against pollution is often helpful to the public authorities in their efforts to prevent or control it.

### *Effect of basic water laws—Common law and prior appropriation doctrines*

It is also important to remember that we have in this country two more or less distinct bodies of law governing private interests in connection with water pollution, corresponding with the basic doctrines of water law prevailing in different parts of the country; namely, the common law doctrines of riparian rights and underground water rights prevailing in the Eastern and Central States, and the doctrine of prior appropriation of water prevailing in the Western States. There are also many lesser differences in water laws among the States within each doctrinal group, depending on local statutes and court decisions. These differences must be recognized and the pollution control laws must be adapted to the basic water laws existing in each State. This is especially true in cases where the use of water is a factor in pollution control.

### *Significance of objectives and interests affected*

In developing and applying water pollution control statutes it is of prime importance to fit the provisions to the objectives sought and the interests affected.

Originally the main if not the only motive for pollution control was public health and the protection of domestic or community water supplies. So the first anti-pollution laws were health laws, and the first agencies charged with the duty of combating pollution were the State boards or departments of health.

With the march of progress many other interests involved in or affected by water pollution entered the picture and demanded consideration—notably agriculture, industry, and recreation.

And now, overshadowing all other considerations, we have at last come to realize that water pollution control is imperative for conservation of water on which our very existence depends.

In the meantime sources and kinds of pollution have multiplied beyond all previous estimates, outstripping efforts at prevention or control. The whole program must be greatly intensified and speeded up to meet the water needs of our mushrooming population.

All these conditions must be reckoned with in projecting the future pollution control program and framing the laws for its advancement. Development of new laws to meet changing conditions must go forward together with or even ahead of other phases of the program. Otherwise, lack of legal authority may block action on urgent pollution problems, with great harm to the public health or welfare.

## II. PUBLIC POLLUTION CONTROL LAWS

We now come to the specific problems of the public pollution control laws and what improvements are needed to make them more effective in the foreseeable future. In the limited time available it will be possible to cover only the main essentials and point out the most critical places where the laws need to be strengthened.

### *Functional divisions*

From the functional standpoint there are two general divisions of the public water pollution control laws:

(1) Administrative and enforcement provisions;

(2) Enabling provisions for construction, maintenance, and operation of sewage or waste treatment and disposal facilities.

The administrative and enforcement provisions are necessarily integrated and are usually embraced in the same legislative act or chapter of the State statutes, although various special provisions in these categories often appear separately. It is desirable to consolidate such provisions, as far as possible, when revising or codifying the applicable statutes.

### *Suggested Water Pollution Control Act*

The main body of administrative and enforcement provisions is illustrated by the suggested State Water Pollution Control Act published under the direction of the U.S. Public Health Service in 1950, with the collaboration of the Council of State Governments, in compliance with a provision of the Federal Water Pollution Control Act.

Answers to the questionnaire indicate that there has been some misunderstanding as to the nature and purposes of this publication. Some people have assumed that it was intended as a model or pattern to which all States were asked to conform. Some writers seemed to think that this was a good idea. Others sharply disagreed, asserting that their present State laws were adequate, or at any rate that the suggested act would not fit their peculiar conditions.

Any misconceptions about the suggested act will be completely set at rest by a careful reading of the introduction and explanatory statement which accompanied it. The act was never intended as a model to be imitated, but as a compilation of appropriate provisions on essential points which might be helpful to the State agencies and legislatures in framing laws suited to their needs. It consisted largely of provisions already in force in various States, with alternative provisions where different solutions were feasible. Thus, it recognized that absolute uniformity was not to be expected.

Uniformity of State laws is both desirable and feasible in many fields—negotiable instruments, for example—but it is unattainable in pollution control by reason of the diversity of basic water laws and the wide variations in conditions among the different States.

The Federal Water Pollution Control Act does not contemplate complete uniformity of State laws in this field. What it says is that the Surgeon General shall "encourage the enactment of *improved* and, *so far as practicable*, uniform State laws relating to the prevention and control of water pollution." [Emphasis supplied.] This clearly manifests an intent to promote not uniformity in language but uniformity in practical effectiveness—assuredly a desirable goal. In compliance with this injunction of the Federal Act, the Public Health Service has now undertaken a revision of the suggested State Act, with the aim of improving its provisions in the light of experience and adapting them to changing conditions.

The same procedure will be followed in this process as in framing the original act. No specific drafts for changes or additions have yet been made. Before submitting any such proposals we wish to digest all the answers to the questionnaire, get the benefit of the discussions at this Conference, and make further studies where necessary. Then a tentative draft of the proposed revision will be circulated among all concerned, inviting further comments, criticisms, and suggestions. After analysis of the returns and further consultations, the final text for a new suggested act will be written and published. In this undertaking the cooperation of all those here present and others concerned throughout the country is earnestly solicited.

## III. ADMINISTRATIVE AND ENFORCEMENT PROVISIONS

The administrative and enforcement provisions of a Water Pollution Control Act embrace four main features:

(1) Declaration of policy (optional);
(2) Definitions;
(3) Administrative agency—organization, functions, and powers;
(4) Operating provisions.

### *Declaration of policy.*

The suggested act and some of the present State acts begin with a declaration of policy. This may be desirable but is not essential.

The purpose of a declaration of policy is twofold: first, to fortify the law against attack on constitutional grounds; and second, to serve as a guide to the courts and administrators in interpreting and applying the substantive provisions of the law.

With respect to the first purpose, declarations of policy are frequently incorporated in new statutes where the State undertakes to exercise control over a field not previously subject thereto, and where there is some doubt as to the constitutionality of the venture. Laws such as these, to be valid, must be justified as an exercise of the police power of the State in furtherance of the public health, safety, and welfare.

There is no doubt at all about the authority of the State to regulate or prohibit pollution which endangers public health, so no declaration of policy is needed on that score. It was the advent of other interests, such as agricultural, industrial, and recreational uses of water, which prompted the framers of pollution control legislation to resort to the use of declarations of policy. However, the courts have now gone so far in sustaining the application of pollution control laws in situations involving not only public health but various other interests that there is no longer much need to incorporate a declaration of policy in order to strengthen an act against attack.

With respect to guiding courts and administrators in construing and applying the laws, it may be observed that the substantive provisions should be so clearly worded that they will speak for themselves and need no aid from explanatory declarations.

However, a declaration of policy, if properly framed, does no harm and may do some good, not only in the respects mentioned above but in promoting support for the law and cooperation in its observance. The main rule to be observed in drafting a declaration of policy is to make it broad enough to cover all possible situations to which the law may apply at the time of enactment or in the foreseeable future, and especially to avoid the use of any language which may restrict the construction or application of any substantive provision of the original act or possible future amendments within limits that might handicap administration or enforcement. The declaration of policy should be checked against every substantive provision, existing or prospective, with that in mind.

### *Definitions*

Definitions are important to clarify the meaning of terms which are not self-explanatory and to adopt short terms or titles which may be used in the body of the act to save language.

### *Definition of pollution*

The cornerstone of any pollution control law is the definition of pollution. As in the present suggested act, it should be broad enough to cover every type of contamination or alteration of the physical, chemical, or biological properties of water that will or may be materially harmful.

### *Limitations on application of the law*

In connection with the definition of pollution, a question of major importance is sometimes raised as to limitations on the application of the law which may be necessary to allow reasonable opportunity for the construction of sewage treatment plants or other pollution control facilities and to exempt discharges authorized by official permits. Efforts may be made by those concerned to have such limitations incorporated as qualifying provisos in the definition of pollution—for example, that such and such a conditions shall not be deemed pollution within the meaning of the act, or that the discharge of sewage or industrial waste under a permit from the pollution control agency shall not be deemed pollution. This would obviously amount to a direct contradiction in terms. It is bad composition, both logically and legally, and should be avoided. Harmful contamination or alteration of the properties of water is indisputably pollution, and no evasive language can make it otherwise. Limitations on the application of the act, so far as necessary, should be incorporated in the operating or penal provisions, as will be illustrated later, not in the definition of pollution.

### *Definition of waters*

Next to pollution, the most important term requiring definition is waters. This should embody a description of the different types of waters, public or private, surface or underground, to which the act applies.

The definition in the suggested act is about as broad as it could be made, covering practically all types of waters on or below ground that could be affected by materially harmful pollution. Such a definition is desirable as a basis for a completely effective pollution control program.

However, for strategic reasons it may be necessary in some States (especially where the doctrine of prior appropriation is in force) to confine the program at the outset to certain classes of waters where pollution is worst and where the need for control is greatest.

Even so, the ultimate aim should be to take in all waters which may be subjected to pollution of any material public consequence.

### *Other definitions*

A number of other terms need to be defined, but time limits preclude discussion of them here. Illustrations are given in the suggested act. These will no doubt be augmented in the revised act in response to suggestions received from different sources.

### *State water pollution control agency*

Orginally, pollution control was handled by the State boards or departments of health, and that is still the case in about one-third of the States. The other two-thirds have created special authorities for the purpose—usually a board or commission, but sometimes a single head.

In any case it is essential to have an executive officer, acting under the direction of the governing body or head of the agency.

For present purposes it will be understood that the term "board" unless otherwise expressly indicated, refers to the governing authority of the State water pollution control agency, whether it is the State board of health or a different body or a single head.

### *Position of water pollution control agency in the State government*

In any case where the water pollution control agency is governed by a special authority other than the State board of health, there is a problem of determining its position in the State government—whether it is to be a separate State department or an appendage or subdivision of an existing department. This is a matter for determination by the legislature in accordance with the general plan of organization of the State government.

However, if the water pollution control agency is attached to another State department (such as the department of health, department of water resources, etc.), it should have independent authority to act on most, if not all, of the matters within the scope of its functions. If the decisions of the water pollution control agency are made subject to approval by some higher administrative authority, it leads to shifting responsibility, creates bottlenecks, and delays action. Such provisions should therefore be avoided, with possible exceptions in the case of adoption of regulations, classification of waters, and other actions of general application and long-range effect, which do not occur very often and which can be made subject to approval of higher authority without delaying action on current business.

Of course, whether the final decisions are made by the water pollution control agency or by some higher administrative authority, they should be subject to appeal to the courts in cases where substantial rights or interests of the parties concerned are at stake. Such right of appeal provides an adequate safeguard against unsound or unjust action by the water pollution control agency even though review by a higher administrative authority is not required. It is a credit to the State agencies of the country that appeals from their decisions have been few and far between.

### *Membership of governing authority*

With respect to the membership of the governing authority of the agency, there are four alternatives:

(1) A board or commission composed of the heads of existing State departments (such as health, conservation, agriculture, livestock, water resources, etc.) serving ex officio;

(2) A board or commission composed of citizens appointed by

the Governor or otherwise selected but having no other official positions in the State government;

(3) A combination of (1) and (2);

(4) A single official appointed by the Governor or otherwise selected.

Although the State boards or departments of health still handle pollution control in a number of States, a much larger number of States have established separate water pollution control agencies because it was found by experience that the boards of health have too many irons in the fire to give proper attention to such a complex field of operation as pollution control, especially in populous and highly industrialized States.

Furthermore, where the functions of pollution control are directly vested in the State board or department of health, the appropriation for that purpose is likely to be regarded by the legislature as just another item in the health department's budget, resulting in less money than when there is a special agency to speak for pollution control and impress its needs upon the legislature.

Despite these handicaps, some of the State boards of health which still handle pollution control are doing a creditable job.

Among the different forms of special water pollution control authorities described above, it is hard to say which plan has been most successful. However, the weight of opinion among administrators in the field seems to lean in favor of a board including both ex officio members and others from outside the State government. This provides representation for both State departments and outside groups concerned with the pollution control program.

### *Representation of interests on the board*

The suggested act contemplates that the appointive membership of the board shall include a representative of municipal government and a representative of industry—embracing the two main groups in society that have the heaviest responsibility for both producing and controlling pollution. This arrangement has proved to be good strategy in States where it has been adopted. The municipal and industrial members have usually thrown their weight behind a strong pollution control program, and have been helpful in overcoming resistance and securing cooperation among the groups which they represent.

As indicated in a footnote in the suggested act, other appointive members representing the general public as well as special groups, such as recreational interests, resort interests, general water resource interests, and others, may be added to the board. To these should be added agriculture and conservation or fish and wildlife interests unless represented by ex officio members. However, if this process is carried too far, it will increase the membership of the board to the point where it will be unwieldy.

### *Advisory council or committee*

Instead of increasing the membership of the board beyond workable limits, the organization of an advisory body is suggested, as is provided in the Federal act. Such a body may be called an advisory council or committee to distinguish it from the governing board or commission.

The membership of the advisory council may be as large as necessary to provide representation for all groups having any substantial interest in pollution control one way or the other. It is of the greatest importance to have representative polluters as well as anti-polluters on such a body. Bringing them together promotes mutual understanding and may lead to workable solutions of difficult problems, avoiding protracted controversies.

The legal provisions for an advisory council should name or clearly define the important known groups entitled to representation and prescribe the manner of selection of the members. In the case of a well-established statewide organization, it may be permitted to designate its own member on the advisory council. Otherwise, the appointments should be made from known adherents of the designated groups by the Governor or other State authority—preferably not by the water pollution control agency.

An elastic provision may also be incorporated giving the Governor or other appointing authority power to add representatives of other groups which may from time to time demonstrate a sufficient interest in pollution control to deserve consideration.

An advisory council has various functions, of which the most important are to make recommendations to the governing board on major policies and problems of public interest and to promote public and legislative support for the pollution control program.

It should be made clear that the recommendations of the advisory council are advisory only and not binding on the governing board. Notwithstanding the advisory council, the board should have full authority and responsibility for making decisions, so that the existence of the council will neither weaken the authority of the board nor give that body an opportunity to shift responsibility to the council.

Opinions differ as to whether the governing board should ever be affirmatively required to consult the advisory council, or should simply be directed to receive the advice and recommendations of the council when offered, giving such weight thereto as the board sees fit. It has been suggested that at least on matters of far-reaching public interest where there is no need for immediate action (such as the adoption of policies or regulations, classification of waters, etc.) the governing board should be required, before acting, to give the advisory council notice that the matter is under consideration and a reasonable opportunity, within stated time limits, to make recommendations thereon. Failure of the council to respond to such a notice would be construed as approval of the proposal. However, even in such cases the power of decision should be reserved to the governing board.

At any rate, the requirement for consultation, if adopted, should not be applied to cases where it might handicap the board in dealing with problems demanding prompt action.

### *Functions of governing board*

Among the most important of a wide range of functions which may be assigned to the governing board are the following:

(1) To administer and enforce all the pollution control laws of the State, whether previously administered by other agencies or not;

(2) To adopt regulations;

(3) To adopt standards for sewage or waste effluents and for the receiving waters;

(4) To classify waters with respect to applicable pollution control standards in view of the uses for which the waters are suitable;

(5) To issue orders for the prevention, abatement, or control of pollution, and to require the construction of sewage or waste treatment or disposal facilities or the adoption of other remedial measures therefor;

(6) To require the submission of plans for such facilities and to approve or disapprove the same;

(7) To issue or deny permits for the construction of such facilities, when approved, and for the discharge of sewage or waste effluents under proper conditions for prevention, abatement, or control of pollution.

Of course, all the functions or duties of the board should be implemented by the powers necessary for their performance, including the power to modify or revoke action once taken when necessary in order to prevent, abate, or control pollution. As will be further discussed, the power to modify or revoke orders, permits, or water classifications serves also to preclude claims of vested rights to discharge pollutants.

Other desirable functions of the board are indicated in the suggested act.

### *Consolidation of enforcement authority—concurrent jurisdiction with other agencies*

In order to promote an effective and comprehensive pollution control program, it is important to give the water-pollution control board authority and responsibility for administering and enforcing all the laws of the State relating to the prevention, abatement, or control of pollution, including special provisions previously administered by other agencies, such as the health laws, livestock sanitation laws, game and fish laws, and so forth. However, it is not usually necessary or desirable to divest the other agencies concerned of their enforcement authority under such provisions. They may be permitted to retain concurrent jurisdiction with the water-pollution control board for prosecution of violations.

Cooperation of county sheriffs, prosecuting attorneys, and other local law enforcement officials (especially health officers) should also be required.

All this can be done without confusion or duplication of effort through proper coordination among the agencies concerned under the general direction of the water-pollution control board. The result is to marshal under a systematic program all the forces available for combating pollution—an obviously desirable end.

To preserve concurrent jurisdiction between the water-pollution control board and other agencies where desired, there should be incorporated in the law (as in the suggested act) a provision to the effect that it shall not operate to repeal or supersede any other law on the subject unless it is expressly so provided or unless there is a direct conflict.

### *Delegation of legislative power*

In connection with provisions authorizing the board to adopt regulations which are to have the force of law in setting standards, classifying waters, or dealing with other matters, it is essential that the law itself should set forth the basic general principles, policies, or objectives governing the action of the board on the subject matter. If the law simply gives the board unlimited discretion in such matters, it may be held invalid as an unconstitutional delegation of legislative power. Under a properly framed provision the board, strictly speaking, is not authorized to make any law itself but simply to make investigations and determine the circumstances under which the basic provisions of the law shall apply to particular situations—an administrative function which the legislature cannot very well perform itself. The original suggested act and State laws may be weak in this respect. It would be advisable for the authorities concerned to examine the applicable provisions and seek amendments to strengthen them against attack, if it appears necessary.

### *Standards—classification of waters*

A number of State laws, like the suggested act, authorize the board to establish standards for effluents or receiving waters and to classify such waters with respect to such standards and the uses for which the waters may be suitable. In the suggested act and in most of the State laws having these provisions the authority is discretionary, with no mandatory provision for establishing a comprehensive system of standards and water classifications before applying the law in particular cases. The boards have usually handled the problem case by case, prescribing in the order or permit for each case whatever standards seemed appropriate under all the circumstances.

However, it is taken for granted that different cases where circumstances are similar will get similar treatment, and this understanding has sometimes been embodied in declarations of policy issued by the boards for the guidance of the municipalities and industries concerned with the treatment or disposal of sewage or waste. In some cases on interstate waters the boards of adjacent States have concurred in such declarations. The result has been to establish classifications of the affected waters which are more or less informal but nevertheless effective for the time being.

However, it is usually made clear that these declarations are subject to change, and that orders or permits issued in connection therewith may be modified at any time in the future to call for a higher degree of treatment or the application of other remedial measures to prevent, abate, or control pollution if required in the public interest on account of changing conditions.

The rub comes when it is proposed to stabilize the standards and classifications through systematic regulations covering all the affected waters in advance, as is already provided by the laws of certain populous and highly industrialized States. Such provisions are the outcome of pressure from municipalities and industries for more permanent specifications for their guidance in planning future developments than are embodied in informal and readily changeable declarations of policy or intention by the water pollution control board.

A large majority of the State agencies throughout the country are opposed to this procedure, fearing that it will tie their hands against the adoption of future improvements in treatment or disposal of sewage or industrial waste, will lead to the establishment of vested rights on the part of municipalities and industries to treat and discharge sewage or waste under presently authorized methods, and in general will tend to lower the level of pollution control. However, as a matter of necessity or expediency, provisions for systematic standards and classifications are already in force in some places, as before stated.

Without taking sides in the argument over the merits of the procedure, we should call attention to some points which should be considered by the State legislatures and all others concerned with this problem before acting upon it. This is a situation, if there ever was one, which calls for the old admonition, "Look before you leap."

### *Systematic standards and classifications—procedure and authority for adoption*

The procedure for adoption of systematic standards and water classifications involves two main steps:

(1) Framing specifications for the standards of effluents or water quality and the classes of waters in which these standards will be applicable according to the uses for which the waters may be suitable.

For example, class A waters would embrace those used for human water supply, where discharge of sewage or waste effluents would either be prohibited altogether or permitted only under the highest possible degree of treatment. Class B waters would embrace those suitable for less exacting uses, requiring less complete treatment of sewage or waste, and so on down the line to the lowest class, where little or no treatment of sewage or waste would be required.

(2) Making investigations, holding hearings, and designating the actual waters assigned to each class.

Obviously, this procedure will result in more or less stable if not permanent zoning of the waters of the State for different uses.

This leads at the outset to the question whether the power of taking action fraught with such grave consequences to present and future generations should be vested completely in a specialized agency like a water pollution control board, or whether it should be subject to review and confirmation, before finally taking effect, by some higher and broader authority—perhaps even by the legislature itself—in order to insure full consideration for all present and future interests involved.

### *Standards and classifications—vested rights*

Another momentous question is whether the actual use of waters for disposal of sewage or waste by municipalities, industries, and others under established standards and classifications will ripen into vested rights for the continuance of such use. Under private land zoning systems, it is usually held that the owners have vested rights in the continuance of established uses, and that these rights cannot be modified or abrogated without compensation for any resulting losses which the owners may suffer. Condemnation proceedings may be necessary in such cases in order to eliminate existing uses and make way for other or higher uses of the property.

Whether the same thing would happen under classification of waters for pollution control purposes is a question which cannot be answered with assurance until it has been passed upon by a court of last resort. Water classification systems have not been in force long enough for such a case to arise. However, the various possibilities in that connection should be considered before developments under such systems get past the point of no return.

Municipalities, industries, and others responsible for disposal of sewage or waste would, of course, like to obtain vested rights to continue the methods of disposal which they may be permitted to adopt upon the initiation of the classification system, so that they could demand compensation if the classification should be raised and more complete and expensive treatment should be required later. At least up to the point where actual use of the authorized methods of disposal is made under the classification system, the matter of granting vested rights is completely under the control of the legislature in the first instance, when it enacts the law, and later of the water pollution control board so far as it may be authorized by law to deal with the problem. Hence the legislature and the board should consider whether it is in the public interest to grant vested rights, and if they decide that it is not, they should incorporate in the law or in the regulations establishing the classification system or in the permits for disposal of sewage or waste, as the case may require, express provisions forestalling the acquisition of vested rights thereunder. That would settle the question, since no claim of vested rights could be sustained in the face of such provisions expressed before actual use of the prescribed methods of disposal began.

On the other hand, if it should be the deliberate purpose of the legislature or the board in a State where the classification system has been adopted to grant vested rights thereunder, on the assumption that the planning and progress of municipal, industrial, or other developments will thereby be encouraged and facilitated, they may and should incorporate express provisions to that effect in the law, regulations, or permits, as may be appropriate, in order to make their intention clear.

As before indicated, we are not expressing any opinion as to the wisdom of such action one way or the other. However, it may be observed that the inevitable result would be to put a damper on the efforts of those responsible for the origin and disposal of sewage and waste to improve their water use and disposal methods. They will naturally try to get by with the least permissible effort and expenditure in that regard.

One of the most important factors in the advancement of the whole pollution control and water conservation program is the possibility of learning by research and experiment how to get along with less water for industrial and other purposes and how to treat sewage and waste more effectively. The incentive for such efforts will obviously be greatly lessened if people can get vested rights to stay in the existing rut.

The interests responsible for sewage and waste disposal have never had any such vested rights in the past so far as the authority of the State for dealing with pollution is concerned. Conceivably an operator, by long-continued discharge of pollutants, might get prescriptive rights to continue such discharge against private riparian landowners downstream, but he could never secure any such rights against the police power of the State to prevent, abate, or control pollution for the sake of the public health or welfare, no matter how long the discharge was continued. Yet vast municipal and industrial developments have gone ahead throughout the country with no assurance whatever as to how long or to what extent past methods of sewage or waste disposal would be permitted to continue. The question may well be asked whether there is any need for providing greater assurance now by granting vested rights in such methods. That, of course, is a question of public policy for consideration by the legislature and the authorities concerned.

However, the problem involves another and deeper question as to whether a State legislature has any power at all to grant or authorize the granting of vested rights in derogation of the police power of the State over water pollution. The police power is an attribute of sovereignty, which cannot be compromised or surrendered either by the legislature itself or anyone acting under its authority.

This is of special significance in connection with navigable or public waters, which are held by the State in its sovereign capacity in trust for the people, without power of alienation. Most major pollution problems involve such waters directly or indirectly. The legislature may doubtless regulate the use of such waters in the public interest, but it is debatable whether it may grant any permanent vested rights therein which would interfere with the exercise of the police power for protection of the waters in furtherance of the public health and welfare.

Here again, until the matter has been passed upon by a court of last resort, it is impossible to say whether an act of the legislature granting vested rights in established methods of sewage or waste disposal, or authorizing the water pollution control board to grant such rights, would be valid. All concerned should take note of this uncertainty and govern their acts accordingly.

### *Standards and Classifications—Inertia*

Even if the acquisition of vested rights in existing methods of sewage or waste disposal under a system of standards and water classification is ruled out, whether by law or court decisions, substantial municipal, industrial, and other developments are bound to go forward in reliance on the system. This will inevitably create an element of inertia in the way of improvements. Even though the people responsible for sewage or waste disposal have been warned by provisions in the law or the regulations governing the system that the prescribed methods are subject to change, they will naturally resist attempts at raising the requirements and will try to maintain the existing provisions as long as they can. It will be much harder to change a classification of widespread application, adopted through deliberate procedure, than to modify a permit governing a single case. This prospect should be taken into consideration by legislatures and others concerned, along with other considerations on both sides of the question, in determining whether or not to adopt a classification system.

### *Operating provisions—Orders, plans, permits, and enforcement*

The things we have been discussing—regulations, standards, and water classification—are preliminary steps to set the stage for action. We now get down to businss with operating provisions.

Under a State law like the suggested act, a water pollution control board proceeds with its mission by investigating actual cases, holding hearings thereon, issuing orders for prevention, abatement, or control of pollution, acting on plans for sewage or waste treatment or disposal facilities, issuing permits for approved facilities, and denying permits for facilities where the prescribed requirements are not met. If the board's mandates in any form are not heeded, it may invoke civil court proceedings to compel compliance, or it may resort to criminal prosecutions, with penalties, to punish violations. These provisions cover a lot of ground. We can take up only points involving legal problems of special interest.

### *Orders*

A board order against pollution may be negative or positive—that is, it may direct that a polluting discharge be stopped—commouly called a cease-and-desist order—or it may go further and require the construction of treatment facilities or the adoption of other remedial measures.

A cease-and-desist order, without any positive requirement for remedial measures, may be effective against a private industry or an individual polluter. The offender may take his choice—either stop the discharge (perhaps requiring suspension or termination of his operations) or he may install facilities for treating the pollutant to the satisfaction of the board. If he fails, his operations may be shut down by a court injunction or he may be subjected to criminal penalties so severe as to force him to comply with the order. However, established industries are practically always allowed a reasonable time for compliance, and in a great many cases they have responded with satisfactory solutions.

A mere cease-and-desist order, however, is seldom if ever an effective move against a municipality, because the stoppage of municipal sewers, in most cases, is unthinkable. Hence it is the practice in dealing with a municipal sewage problem for the board to issue a positive order to the municipality directing it to provide sewage treatment or disposal facilities meeting specified requirements within a stated time limit. This is expressly authorized under the suggested act and a number of State acts.

In some States where the law provided only for prohibitory orders, the courts have construed the statute by implication as authorizing the board to issue positive orders for remedial measures, because, as before stated, a mere prohibitory order against the discharge of municipal sewage would be ineffectual. However, it is not always safe to depend on favorable judicial interpretations, so the agencies in States where only prohibitory orders are now authorized by law would do well to seek amendments providing for positive orders for the adoption of remedial measures as well.

Some further problems involving enforcement of orders will be discussed in connection with that subject.

### *Plans and permits*

The authority of pollution control boards to require the submission of plans and to issue or deny permits for treatment or disposal facilities is now well settled and widely accepted. Such requirements have been held to be binding on municipalities to the extent that expenditures for sewer extensions or other disposal facilities without approval of plans and issuance of permits by the board would be a misuse of public funds, subjecting the responsible officials to severe penalties—perhaps even removal from office. This has given the boards a powerful leverage over municipalities where sewer extensions are needed to serve new housing, industrial, or business developments. It has been the practice of the boards in such cases to deny permits for sewer extensions until the municipal authorities proceed in good faith to provide for sewerage treatment plants and other necessary pollution control facilities. This procedure has brought about the construction of such plants and other facilities in many cases without resort to enforcement proceedings. It has had widespread effect in the times of booming construction which we have had since World War II. However, it would not get very far during a depression or recession, and it gets no results in static places where there is little or no new development or where the townspeople would rather get along without the sewer extensions than pay for a sewage treatment plant. At best it is a slow process. Boards must be prepared to take more vigorous action in such cases if they expect to accomplish their mission.

### *Permits—Modification or revocation—Vested rights*

The desirability of reserving the right to modify or revoke permits (as well as regulations, standards, and water classifications) in order to prevent the establishment of vested rights in presently authorized methods of pollution control has already been pointed out. Where the law provides for modification or revocation of permits (as in the suggested act and similar State laws), it should be so stated clearly in each permit, so that there will be no misunderstanding about it. However, even without such a statement a permit would, of course, be subject to modification or revocation if the law so provided.

Industries would naturally like to get firm or irrevocable permits. Sometimes promoters will assert that such permits are necessary in order to secure funds for construction. This argument is used in favor of systematic classification of waters. However, if industries cannot get irrevocable permits, they will manage with changeable permits, as they have done on a wide scale in the past.

The reasons why it may be inadvisable and perhaps constitutionally impossible to grant vested rights in the establishment of water standards or classifications have already been pointed out. The same observations apply to permits.

At any rate, a board should never undertake to issue a firm or irrevocable permit unless expressly authorized by law. If it did, the permittee would be leaning on a broken reed, since the permit, if attacked in court, would doubtless be held invalid, so far as the irrevocable feature was concerned, as being beyond the legal authority of the board.

It is unlikely that any problem will arise over the issuance of firm or irrevocable permits to municipalities, because they are creatures of the legislature, and their officials generally understand that laws and orders relating to their affairs are always subject to repeal or amendment.

### *Delegation of functions*

To expedite business it is important to have in the law, as in the suggested act, a provision permitting the board to delegate to its executive officer or other agents or employees authority to act on plans, permits, and other routine business, under conditions prescribed by the board and regulations or delegation orders, reserving matters of major importance for action by the board.

### *Enforcement by civil court action*

The suggested act and similar State acts provide for enforcement of the provisions of the law or orders of the board by injunction proceedings, as in case of abating a public nuisance. This is a well-recognized form of civil action.

This procedure, like a board order to cease and desist, is a negative remedy because an injunction in the ordinary form is simply a court writ or decree restraining one from doing something. That is effective if the only objective is to stop a polluting discharge.

However, an ordinary injunction would not be effective if the objective were to require the construction of a sewage treatment plant or other pollution control works. For this a mandatory injunction or writ of mandamus—a command by the court to do a certain thing—would be needed. This procedure is already expressly authorized in some States and in others it has been sanctioned by court decisions construing the law to that effect. State laws lacking such provisions should be amended to incorporate them.

Disobedience of a writ of injunction or mandamus is punishable as contempt of court by a fine or jail sentence, under the recognized powers of courts of equity or courts of general jurisdiction. However, it would be well to have an express provision to that effect in the pollution control act to make sure of the punitive powers of the courts and serve as a warning to offenders.

Returns to the questionnaire show that actual infliction of penalties has rarely been necessary in pollution control cases. Polluters will often stall action as long as they can under board orders, but when faced with a court writ or decree that has become final after exhaustion of defensive remedies, they understand that it means business, and usually comply without being forced by contempt proceedings.

Some special proposals for other enforcement measures will be discussed later.

### *Enforcement by criminal prosecution and penalties*

Admittedly a pollution control law must have teeth in the shape of provisions for prosecution, with attendant penalties, in order to be completely effective. It is no more possible to secure pollution control on an adequate scale by voluntary action than it would be to collect taxes or obtain universal military service in that way. The obvious reason is that sewage treatment plants and other pollution control works cost money but seldom produce any direct benefits to the owner. Doubtless such facilities result in many indirect benefits, but direct incentives for their construction in the shape of material rewards are usually lacking. Many of those responsible for pollution will voluntarily abate or control it if they are assured that all others in the same boat must do likewise. However, they will not move if they see other polluters continue unrestrained, escaping the cost of remedial facilities and thereby gaining competitive or economic advantages.

The prime requisite of good enforcement provisions in a pollution control law is that they shall be workable, realistic, reasonable, and effective in accomplishing the aim of preventing, abating, or controlling pollution. Punishment of offenders is only an incidental consideration. It does no good to fine a polluter or send him to jail if it does not result in curing the pollution evil.

The problem of devising provisions to meet these requirements is far more complicated than dealing with a common crime like theft—which is not so simple either. There are some cardinal rules of criminal prosecution (of which we speak with experience). No case should be started unless there is a reasonable chance of conviction both on the law and the evidence. No action should be threatened or initiated that cannot be finished. A case that is lost for lack of adequate grounds discredits and weakens the enforcement authority. An unenforced or unenforceable law on the statute books creates disrespect for all law.

The same rules apply, so far as pertinent, to civil enforcement actions.

The main penal provision in the suggested act and many state acts makes any discharge of pollution (as previously defined) unlawful and subject to punishment by fine or imprisonment, with cumulative penalties for each day the offense is continued. This provision has some serious shortcomings in comparison with the requirements outlined above for a good enforcement provision.

The existing provision may be workable against specific acts, such as deliberate or careless spillage or release into public waters of oil, poisonois chemicals, or other particular pollutants where responsibility can be fixed on a certain individual or corporation. It is, however, utterly unworkable against a municipality, where, as before pointed out, stoppage of the sewers is unthinkable, or against a going industry, where stoppage of the discharge would compel the plant to close, throwing employees out of work and perhaps forcing them on relief at public expense.

We have heard of no State having such an enforcement provision where the water pollution control board has set out to enforce it literally by seeking prosecution of every municipality, industry, and private individual responsible for discharging pollution as defined by law. If any such effort were made, the short-handed staff of the agency would be so busy making investigations, gathering evidence, and appearing as witnesses at the trial of cases that they would have no time left for the performance of their other important constructive duties.

The fact is that the pollution control boards of these States, without exception as far as we know, being endowed with common sense, simply do not start any such program of wholesale prosecutions. With the aim of getting maximum results from the limited means at their command, they devote their efforts to the orderly operating procedures described above, and thus attain some measure of success in controlling pollution.

Yet there is the strict penal provision in the law, sticking up like a sore thumb, and every now and then some zealous crusader flaunts it in the face of the board or its staff, demanding to know why it is not enforced. This is both embarrassing and demoralizing, for there is no answer that will satisfy the questioner.

It is time to set the sights on the main objective—prevention, abatement, or control of pollution—and to deal with this problem sensibly in view of that objective. To that end it has been suggested that the penal provision in question be amended to the effect that only such pollution is unlawful as is determined by regulation or order of the board to be substantially injurious to the public health, safety, or welfare, and that no discharge of sewage or waste in conformity with a permit issued by the board shall be deemed unlawful.

Even with that qualification the provision would be stronger than is found in some of the State acts. However, it would not be so extreme as the present provision in the suggested act and others conforming therewith. It would meet the specifications for a good enforcement provision above indicated, and it would extricate the water pollution control boards concerned from their present dilemma.

The suggested modification of the main penal provision of the law would not in any way impair the force of other specific statutes which penalize overt acts of pollution—for example, discharging or depositing contaminating substances in waters used for human or livestock water supplies, polluting waters so as to kill fish, etc. Such provisions can be left in full force, subject to enforcement by the agencies already charged therewith, under concurrent jurisdiction of the water pollution control board as before suggested.

Besides the main penal provision just discussed, it is essential to have in the law (as in the suggested act) provisions, with penalties attached, prohibiting the construction of any sewage or waste disposal works or parts thereof or modifications thereof or additions thereto (as well as certain other acts) without a permit from the board and requiring the submission of plans for such projects.

In that connection it has been suggested that the present provisions be strengthened by requiring that plans for sewage or waste disposal facilities be submitted and a permit obtained therefor before any construction begins on a plant which will discharge sewage or waste for which a permit is needed. This appears to be a salutary proposal. It would relieve the board from pressure from industries that build their plants first and then apply for waste disposal permits under dubious conditions. It would also protect an industry against the loss that would result if a plant were built first, only to discover too late that the location or the manner of construction was such that a permit for waste disposal was unobtainable.

With the modified penal provisions of the Water Pollution Control Act above suggested and the other statutes dealing with overt pollution offenses, the law as a whole would be in good shape for effective enforcement.

### *Grandfather clauses and exceptions*

In some States enforcement of the pollution control laws is handicapped by provisions excepting from the operation of the law discharges of sewage or industrial waste existing at a certain date, or excepting certain types of industrial waste or certain areas altogether. Adoption of such provisions may have been necessary to appease influential special interests and get the law passed in the first place. However, they are a thorn in the flesh of pollution control agencies, because they limit the scope of operations, discriminate against other sources of pollution, make it difficult to deal with them, and so retard the advancement of the entire program.

Needless to say, it will be necessary to eliminate all such restrictive provisions in order to gain the end of complete pollution control. Efforts should be made to get them repealed as soon as possible. It should be possible to overcome the opposition of the industries affected by pointing out to them that there are a number of highly industrialized States where no such exceptions have been made, and by assuring them that they will get fair treatment and a reasonable opportunity to provide waste control facilities if they are made subject to the law. Even if their opposition cannot be overcome, after a good number of other polluters have provided treatment facilities, the weight of their influence and general public opinion should be enough to secure repeal of the objectionable provisions.

## IV. ENABLING PROVISIONS

Even the most effective penal provisions will not in themselves suffice for an adequate water pollution control program. This is recognized by a footnote in the suggested act, pointing out that where the water pollution control board issues an order for construction of a sewage treatment plant by a municipality, there must be adequate statutory provisions for financing the project and otherwise enabling the municipal officials to complete it. Progress of the program has been severely handicapped in many States for lack of such provisions.

On the other hand, in some States the enabling laws are quite adequate. The problem is to get the least effective laws amended so that they will be equal to the best.

Enabling law provisions presenting serious problems are of two types—(1) financial, and (2) organizational—that is, providing for the creation of sanitary districts or other local governmental units to deal with sewage disposal and other pollution control problems where existing cities, villages, or other units are inadequate, or, in some cases, providing for joint contractual arrangements.

### *Financial problems*

The chief stumbling blocks in financing sewage treatment plants and related projects are bond issues and debt limits.

### *Bond issues—Elections*

A difficult problem with respect to bonds arises in States where bond issues must be approved by a vote of the people. Construction of many badly needed sewage treatment plants in such States has been repeatedly delayed and in some cases stalled for the foreseeable future by adverse votes at bond elections.

On the other hand, a bond election has educational value. Some authorities favor bond elections in all cases on this account, because if people are persuaded to vote money voluntarily for a sewage treatment plant, they will take pride in it as a community accomplishment, and will support its future maintenance much more willingly than if they are compelled through legal proceedings to construct it—in which case they are apt to look on it as a millstone around the municipal neck.

There are some who say that despite the damaging consequences an adverse vote at a bond election must be accepted and put up with as the people's decision under our democratic form of government. This view ignores the fact that the people of a community have an obligation to remedy the pollution of which they are the source so that it will do no injury to others—an ancient precept of the common law, now embodied in express statutory provisions. When people by collective action at an election can evade a positive legal obligation of that kind, it is a mockery of the democratic process. There should be and are effective ways to get around such an obstruction.

*Bond issues without elections*

The problem has been successfully solved in a number of States by authorizing municipal councils to issue bonds for sewage treatment plants and other disposal facilities without an election. In some States the provisions dispensing with bond elections apply to all sewage treatment or disposal projects. In others it applies only where construction of the facilities has been ordered by the State water pollution control board.

Sometimes a public hearing is required before a municipal council can issue bonds without an election. Favorable public sentiment at such a hearing can be developed by a preparatory campaign. The whole process takes less time and is much less expensive than with a bond election, and the results in terms of public support for the project may be as good or better. There are cases where opposition which might have gotten quite hot at an election campaign has cooled off completely when a courageous council took the bull by the horns and put through a bond issue on its own initiative.

On the other hand, there have been some cases where municipal councils deliberately sidestepped the responsibility and put bond issues up to the voters rather than exercise their own authority as they might have done under the law. To meet that situation it would be desirable for the law to provide not merely that a bond election is not required where construction of facilities has been ordered by the State board, but that in such a case the council must issue the necessary bonds without an election. There are existing precedents for such laws.

*Revenue bonds versus general obligation bonds*

In some States the authority to issue bonds without elections applies only to revenue bonds, based on specific income from assessments, sewer use charges, or other special sources, and does not extend to general obligation bonds backed up by tax levies and by the full faith and credit of the municipality. Revenue bonds usually take a higher rate of interest than general obligation bonds unless the sources of revenue are exceptionally good. However, the difference is not always great, and many issues of revenue bonds at reasonable rates of interest have been made.

It would be desirable, of course, to have the authority for issuing bonds without elections extend to general obligation bonds as well as revenue bonds, or a combination of the two characteristics. This would certainly be justified in view of the critical importance of pollution control. A bond issue framed so as to be amortized primarily out of special revenue, although made a general obligation as additional security, usually will be paid off out of the designated revenue, without resorting to a tax levy. In that event the only effect of the general obligation feature is to get a lower rate of interest.

### *Debt limits*

It frequently happens that a bond issue for sewage disposal facilities would exceed the statutory debt limits of the municipality. The obvious remedy for this, in force in some States, is to provide that the debt limits do not apply to such projects. This is a fully justifiable measure for the same reasons as in dispensing with bond elections.

### *Constitutional limitations*

In some States provisions requiring municipal bond elections and setting debt limits are embraced in the State constitution. It is admittedly difficult but not impossible to amend the State constitution. Many amendments of much less public importance have been approved by the voters of various States.

The need for advancement of the pollution control program is so urgent that all possible efforts should be made to remove constitutional obstructions wherever they stand in the way.

### *Compulsory bond issues, tax levies, and other measures*

Judging from some of the answers to the questionnaire, the idea of compulsory bond issues, with necessary supplementary provisions for taxes or revenue to pay them off, strikes some people as shocking if not subversive of the principles of local self-government. However, a much larger number think it is a good idea. Those who look askance at such proposals may be surprised to know that they are already in force in some places.

Actually there is nothing more startling or contrary to the principles of self-government in such a provision than in the already general practice of compelling municipal councils through court proceedings to take the necessary steps for construction of sewage disposal facilities. Issuing bonds and providing funds to meet them are usually necessary steps in the project. Unless those steps can be compelled, the enforcement proceedings are futile.

Compulsory procedure would be difficult, of course, if the law required a bond election. In that event all the court could do would be to compel the council to submit the proposal for a bond issue to the voters. If it was turned down, the council could hardly be held punishable for contempt. The responsibility would be on the voters, and how to reach them with contempt proceedings would be a problem. There is a notable case where the court indicated that if a bond issue for a project which had been ordered failed to pass at an election, representative voters might be haled before the court and punished for contempt. History fails to report the outcome.

Efforts should be made to remove all legal obstacles and provide for the construction of sewage disposal facilities by some inescapable procedure in those cases where the State pollution control board has ordered construction and the responsible legal authorities have refused or failed to act. Perhaps it will be sufficient if the law dispenses with bond elections in such cases and gives the courts power by mandamus to compel municipal councils to go all the way with the necessary steps, including bond issues, tax levies, and revenue charges if required.

It would be only a short step further to authorize the court to make orders or decrees actually putting such measures into effect if stubborn municipal officials should persist in their refusal to act despite the penalties imposed under contempt proceedings. This would be no more drastic than what is commonly done already in enforcing the payment of money judgements against municipalities by compulsory tax levies under court orders. However, it would probably be advisable first to strengthen the laws, wherever necessary, for enforcement by injunction and mandamus, and see how that works before seeking more drastic remedies. The point is that to be completely effective the law should provide a sure method for securing the construction of pollution control facilities without fail in all cases where the water pollution control board has determined that it is necessary in the public interest.

### *Special local agencies for sewage disposal and pollution control—sanitary districts*

In these days when population is exploding and development of residential, business, and industrial areas is spreading rapidly beyond present municipal limits, it is becoming increasingly necessary to provide for the organization of sanitary districts or similar special local governmental units to deal with sewage disposal and other pollution control problems. There are also cases where municipalities or parts thereof need to join with adjacent municipalities or outside territory in dealing with these problems, and where it is necessary either to organize a sanitary district or other agency for the purpose or to handle the situation by joint contractual action.

Many States already have laws providing for formation of sanitary districts or similar agencies, but quite a few do not. Moreover, in those States having such laws it may be desirable to revise and modernize them in the light of experience to meet new problems that are continually arising.

Here we can do no more than call attention to the problem, which has many angles requiring separate discussion. Two years ago, after a study of the pertinent laws of various States, we drafted a comprehensive bill on the subject for consideration by the Minnesota Legislature. It got stuck in the legislative jam and did not pass, but will no doubt be introduced again at the coming session next January. Copies of this bill were sent to the pollution control agencies of all the other States, in recognition of their response to the questionnaire that had previously been circulated. If anyone has any questions, comments, or criticisms on this bill, we shall be glad to get them for further consideration.

### *Joint powers law*

Attention should also be called to the fact that where adjacent municipalities have common sewage disposal or pollution control problems that are not too complicated, they can sometimes be successfully handled through a contractual arrangement under a joint powers law such as is in force in California, Minnesota, and some other States. States which do not have such a law should adopt one.

## V. CONCLUSION

Answers to some of the questionnaires indicated that the writers thought that their existing State pollution control laws were adequate even though they lacked some of the features essential for a fully effective program such as we have been discussing. The inference was that the program in the State of the writer was making satisfactory progress and that no improvements in the laws were needed to facilitate or accelerate it. Any State in which that happy situation exists is indeed to be congratulated. However, the great majority of the State agencies are evidently keenly aware of the fact that the water pollution control program is far below par in most areas. They realize further that it will not be up to par until it can not only meet all present needs but also anticipate future needs, so that existing pollution control facilities will be maintained, improved, and enlarged under a continuous process and new facilities will be constructed in time to handle increasing pollution loads and deal with other new problems that are continually arising with the growth of population before injury results from uncontrolled pollution.

A number of States can point with pride to the fact that a large majority of their municipalities, with an even higher percentage of the sewered population, are now equipped with sewage treatment plants.

However, this does not by any means tell the whole story. A more realistic report would include a statement on the capacity of these plants to handle the increasing pollution loads to be expected, together with an estimate of the work needed to bring them up to par as well as to provide effective pollution control facilities at all other places where needed. No progress report is ever complete without a projection of the unfinished work ahead.

The fact is that most of the past progress in pollution control, like other human enterprises, has followed the line of least resistance. Of course it is good strategy to follow that line as far as possible and make the most of voluntary action. An ounce of cooperation is worth a pound of compulsion.

However, as experience has shown in many places, the program is now getting down to the tough nuts, some of which will have to be cracked by force. This is indicated by the cases that have gone to court in the last few years. It is encouraging to note that the courts have usually sustained the pollution control laws and the acts of the State agencies thereunder. Yet it will undoubtedly be necessary to take further cases to court as resistance is met from time to time.

So it behooves all the agencies concerned not only to size up the job to be done but to look to their laws and make sure that they are in shape to see it through.

Finally, lest anyone should think that because I am a lawyer I attach too much importance to legal provisions, let me say that for many years I served also as an administrator in this field, and sweated through many a battle over budgets, projects, and all the other troublesome problems which go with that responsibility. Hence I am heartily in accord with the comments made by many of the State executives who answered our questionnaire, pointing to the acute need for more administrative, technical, and legal help and for more expense money in order to attain their goal of complete and effective pollution control.

The people of the country and their representatives in State legislatures and Congress must be aroused to the fact that skimping on means for essential conservation work like this results in losses of vital water resources worth many times the cost of an adequate program, and that money spent on such a program will come back with dividends many times over in the shape of a stronger and more prosperous Nation.

We are fond of saying that we have a government of laws and not of men. That is an utterly misleading statement. No law is self-executing. What we have is a government of men under law, and both are essential to the success of any public endeavor.

# DISCUSSION

RICHARD T. SANDERS

***Director, Division of Legislative Drafting and Codification of Statutes, North Carolina State Department of Justice, Raleigh, N.C.***

My task, as I understand it, is to draw highlights from Mr. Wilson's remarks, and to provoke and stimulate the thinking and action of the Conference—perhaps to suggest basic legal approaches upon which the foundation of any structure of accomplishment of this Conference is obliged to rest. I interpret Mr. Wilson to affirm that law must effect a fundamental commitment of government to the principle and practice of conservation of waters for best usage. In essence, he places major emphasis upon the necessity of effective teamwork of dedicated men working under and through an effective system of law, for the purpose of achieving that end. With his fundamentals, I find myself in hearty agreement. He has, as I see it, performed signal service in suggesting a set of measuring rods, criteria, or tests which may be used to judge the effectiveness of water pollution control law. Since we may all agree that State water pollution control laws are so vital and of such paramount importance in the implementation of the whole program, or any effective program of water pollution control; and since the suggested or model water pollution control laws as developed by the Public Health Service represent a truly significant part of the Federal initiative, assistance, and leadership which has been dramatically fruitful in this field, I deem it exceedingly appropriate that Mr. Wilson has taken the suggested water pollution control law and its variables among the several States, as the frame of reference for his fundamental subject matter.

I should like for the Conference to confront the tremendous and growing problem of water pollution in the exploding metropolitan fringe areas where towns or unincorporated developments, small in themselves—so small, in fact, that separate sewerage plants are not economically feasible—aggregate a greater pollution threat than the central city itself. There a multi-municipal participation is of unquestioned advantage, but difficulties can be envisaged in determining the share of grant and burden for each participating municipality and the legal responsibility where all are not equally responsible. Then, who is to assume the financial, administrative, and legal responsibility in the case of unincorporated metropolitan fringe areas where there is a conflict of interest as to sanitation facilities within the county between the urbanized fringe and the rural areas? How can a worthwhile pollution control project even get started under such circumstances unless provisions are made by law which meet the special problems presented and preserve at the same time the principle of maintaining responsible local government?

While local political subdivisions, municipal corporations in any form, are creatures of the State law, the States themselves are not creatures of the Central Government. This country fought the bloodiest of all civil wars and has been said to have established thereby the indivisibility of the Federal Union and the indestructibility of the sovereign States. The natural fact that waters are no respecters of political boundaries is no justification for any water law approach destructive of the integrity, the authority and the effectiveness of local and State governments and the preservation of their sovereignty in the Federal system.

At the same time, in the field of the law of water resources, and particularly the pollution control aspect of that field, there is no place for a twilight zone. There must be a full suit of legal armor. The interrelated legal systems should be mutually supportive and complementary, rather than mutually exclusive, inconsistent or competitive. The integrity of the State's laws for the State itself and its subdivisions must be respected and preserved. Laggard States like laggard subdivisions of States may well be encouraged to responsible and effective action by standby or emergency authority for the preservation of the resource, as expressed in Federal and State laws. But the exercise or assertion of authority, in the name of paramount power, must not be permitted to preempt the field of State and local government, bring about an ouster of such governments, encourage abandonment of local effort, or dissipate the energies and efforts of all governments concerned in fruitless and pointless jurisdictional controversy, to the detriment of the public interest. At all levels of government, therefore—Federal, State, and local—the function of law is simply to commit to a goal, define and allocate responsibility for the achievement of the commitment, and provide authority commensurate with the responsibility. I am persuaded that men of inspiration and good will can do this—and we must.

The Federal Water Pollution Control Act has served a most excellent purpose. It recognized that proper treatment of effluent before discharge, while primarily an act on behalf of others, is a worthy contribution to the public interest and to the preservation on behalf of the whole body politic of a vital resource. Federal grants-in-aid have proved to be a most effective incentive. Local matching funds for the construction of waste treatment plants far in excess of the Federal grants-in-aid have been encouraged and expanded, and the benefits of the act itself—of the principle it embodies and the program it instituted—to the body politic cannot actually be expressed. They are far too great. It has not sought to destroy local authority or responsibility, but has, on the contrary, encouraged local governments to shoulder broader responsibilities and provided help and guidance. I admit that the Federal act needs strengthening. The avenue, to pinpoint the individual sources of pollution and to concentrate on elimination at the points of origin is an approach open to criticism from the larger view of comprehensive control, but the approach has worked well, and as helpmate to the related conservation programs it offers a justified hope for the achievement of comprehensive pollution control and is eminently worthy, therefore, of retention and expansion.

May I beckon you to lift your vision a little higher? Divine Providence has provided life on this planet a few basic things—a relatively thin crust, of cradled soils and waters, a surrounding cushion of air, and an interchange system of moisture between to constantly replenish and nourish the waters and soils of earth. Overall He anoints with the warmth and light of the sun. With these things, all human life, all endeavor, all fish, fowl and animal life, all the vegetation for their provision, must be sustained, and I believe these resources abundantly sufficient to the task. I am persuaded that they are enough to support and enrich all life, all gainful endeavor, even all beneficial growth, now and in our beckoning future. It is within the destiny and capacity of mankind to plan, develop and deal with these treasures comprehensively and as a unity, reflecting our realization of the conjoint, interacting, and interrelated nature of these resources, and our use of them. As to the legal aspects of our stewardship of these resources, I am persuaded that as men of law, men of science, men of government, and plain good citizens, we will achieve a coordinated system of laws. These laws must harmonize the legal pattern with the laws of nature. They must reflect the distilled best judgment of man, and their effectiveness will be limited only by the limits of man's inspiration. Let us hope that here, at long last, interdisciplinary cooperation and understanding between men of law and men of science will have reached fruition. The ultimate public weal demands no less.

But we deal with the problem of the waters of earth, and more specifically, of the waters of the United States. May I suggest that the attack be on a broad front, rather than on a fragmented portion of the water problem. Water quality, water quantity, water navigability, water for the parched lands calling for reclamation—water for municipality, recreation, industry, agriculture—all cry out with equal fervor for our attention, and if we retire within our airtight compartments of self-centered concern, our little hegemonies of narrow responsibility and narrow inspiration, to be sure we foreshorten ourselves on the very threshold to fragments and fringes, rather than hear issues of the overriding problem of water itself.

Just a word in support of the above assertions. Without low flow regulation of streams, where will the volume of water necessary for carriage and natural purification of waste be obtained? No waste treatment system or systems on earth nor their sum total can equal the roll of water itself as the purifier of pollution nor match the built-in treasure of the natural oxidation principle. To insure a steady flow we must take action which supports and complements the natural processes. No user of water—no man—is an island—but what we all do affects each of us, and what we each do affects all of us. We must build installations for retardation, interception and storage—even for an occasional diversion—and here, indeed, we find ourselves in the thicket of water law problems, and both the riparian and prior appropriation doctrine rear their frightening heads.

I believe water law, both public and private, should truly reflect an abiding purpose to make an abundance of waters actually rather than potentially available in abundantly useful quality, in abundant quantity, and abundantly in time for beneficial use, now and in this country's future. This, in essence, is the fundamental goal of conservation of waters. I do not subscribe to the belief that conservation has been conscientiously tried and found wanting in this country, for I rather suspect that broad and true conservation for use may have never been, indeed, tried at all.

Accordingly, I see the main challenge to us and to law is to perfect the posture of planning, controlling, regulating, managing and developing the resource in strength and not in weakness. Finally, I desire to reemphasize the obligation of law and government at all levels to undertake a fundamental commitment to a basic principle, to assume and allocate responsibility for achieving reasonable goals in keeping with the basic commitment, and to provide ample authority to carry out the assigned responsibilities. Coming a little closer to cases, I urge that we thus deal with river basin systems, watershed systems, State river systems, and interstate river systems, with power and authority at all levels of government—Federal, State, and local—commensurate with the problem and the area faced, and I believe that we cannot but succeed.

## Panel III

### General Discussion:

**Dr. WOLMAN.** Mr. Edward P. Thornton has asked to make a statement from the floor. He is the chairman of the New England Compact Commission.

**Mr. THORNTON.** I am Edward P. Thornton, chairman of the New England Interstate Water Pollution Control Commission, and member of the New Hampshire Water Pollution Commission.

I have asked for this opportunity to speak because I find myself in considerable disagreement with some of the policies enunciated both this morning and this afternoon by some of our speakers. Knowing that you are going to present conclusions of this group, and knowing that those conclusions will have considerable weight, both tomorrow and in the future, I feel impelled to set the record straight both for the State of New Hampshire and for the seven signatory States of the New England Compact. We do not feel that there is any need for any extension of the Federal jurisdiction over that presently exercised by the Public Health Service.

We in New England are very happy with our natives. We get along with them; we get along with the Federal Public Health Service. The representatives who are regularly assigned to our New England meetings and to our New England States are fine gentlemen. They have our respect and confidence.

This noontime, I suggested to Mr. Forsythe I would be very happy to have any case histories related by him, as to the need for Federal enforcement authority, but he had none. We do not have any instances known to any of us in New England on which there was any conflict between States or where there was any conflict in which it is necessary to call in even the present provisions of the Federal law. We feel that there is a definite area in which the Federal agencies can and should operate—the question of coordination of training, the use and assistance that they can give us in preventing duplication of training facilities and, most of all, of course, is the question of cash.

Every one of the speakers has pointed out that the main point of all these pollution problems is the question of money. Who is going to pay for abatement?

Again, to go back to New England, we have a fairly decent operating setup there. We are getting along, not spectacularly but nevertheless, getting along, and we are doing the job. I don't want to be smug, but we could do better. There is no question about it. Every one of us could do better, but we are getting along and are doing our job in New England. And we are doing it with a minimum of difficulties and at what we think in New England is the proper governmental level, namely, the smallest possible local level.

We believe in town meetings in New England. We believe in giving people a right to be heard and to make their thoughts known. We try to govern ourselves as much as possible on that local level. We in New England, New Hampshire, Maine, and Vermont, particularly, have taken full responsibility for the water pollution control program.

There is no question up our way of whether or not it is needed. There is no question about whether it should be done. It is merely a question of time and money. The time is the same amount that all of us have. But as far as the money is concerned, at least three of the New England States have passed laws which make a cash contribution. In New Hampshire, it is 20 percent, the same basis as the Federal contribution of 30 percent is made.

In addition, we have some other provisions that are of assistance. One of those provisions which is extended to any municipal subdivision of the State is a State guarantee of the bonds. And that has amounted to as much as 1¼ percent difference in the rate of interest on those bonds when they are issued, not a small saving over the life of a 20- or 25-year bond.

We have, in addition to the State aid and the State guarantee, a means of aiding industries. We in New Hampshire give a 25-year tax abatement to that portion of any manufacturing or industrial plant which is devoted to the abatement of either air or water pollution. That, you can readily see, is a very definite advantage to the industry involved.

There are several other points I would talk of, sir. I would like to point out that many of us in the water pollution field have other State activities involved.

Just in reference to the suggestion that was made this afternoon about the telephone and water taxes, I suggest that those of you who are in the State health or water pollution agency might very well be in a most embarrassing position if you found you were advocating this type of action in contradiction to another State agency. And I suggest before you take any stand in your respective States that you do two things. Pick up your telephone, call your Governor's office and ask what the Council of State Governors and the Governors Conference is doing on it. And call up your public utilities commission and ask them what the National Association of Railroad & Utility Commissioners have done on this particular point.

Just to summarize it, sir, I would like to say that in New England there is no need for any further extension of Federal jurisdiction other than that which we now have. We feel that our people and our industries are going to get a lot better hearing in their own State capital. Certainly, it is a lot less costly hearing to them in their own home State than having to come down here to Washington. We feel that they will get a much better break on the economic aspects of the situation from their local people than they will from the Great White Father down in Baghdad on the Potomac.

In any event, to summarize, I would like to offer this following motion. I don't know whether I am in order or not. I offer for adoption this resolution, sir:

That this panel go on record as being opposed to any further extension of Federal jurisdiction other than that presently being exercised.

**Mr. MIKELK.** I am Stanley F. Mikelk, member of the Massachusetts Fish and Game Board. Also I am the Izaak Walton League delegate to the Conference. We in Massachusetts have a program that will seek all Federal aid, following the principles of some of the enlightened members who are on the panel today and have spoken. I think Mr. Thornton has gone far afield. We are satisfied in Massachusetts with what the compact is doing.

I was instrumental with a number of other conservationists in drawing up a conservation platform which was presented to our candidates for Governor of both parties. Both candidates campaigned on the platform, and they made promises that would appear to be inconsistent with the resolve presented by the gentleman from New Hampshire.

The gentleman from New Hampshire has told you of an enabling law in three Northern States of Maine, New Hampshire, and Vermont. But I do think he is quite unfamiliar with the scene in Massachusetts.

We definitely are not satisfied with the progress in Massachusetts, and we do know we can make more progress if we get more Federal help and the help in the various new fields needing research. That will certainly be of help to us in the future. I hope that the Blatnik bill will pass. We in Massachusetts are more concerned with the passage of the Blatnik bill than with the passage of the resolution proposed by the gentleman of New Hampshire.

**Dr. WOLMAN.** I thank you very much.

I suppose the chairman must make a ruling as to whether or not this discussion should be resolved in the form of any motions of approval here today. I believe that in general our purpose has been to hear as many viewpoints as we can during the sessions without formal resolutions today, regardless of the direction or their nature, or even their popularity.

I think I might say that for the sake of the audience in this last, a little bit more heated discussion, which I for one happen to like because I think we were getting a little too quiescent during the day, we were getting almost to the point where there seems to be unanimity of opinion, even though I wasn't too sure what that unanimity was. But just for the assurance of the audience, I do want to say that all guns have been removed at the entrance to this assembly so that the motions are both temporary and not dangerous to your lives.

I hope that the Conference will agree with me that we are not yet ready for resolutions of approval or disapproval. This, I place on the basis that we have a working session of a small group this evening with the idea of trying to formulate something which will be more than a series of pious declarations in favor of virtue and against sin and bring them back to you tomorrow so that you may have an opportunity to determine whether in an audience such as this, which is bound to have some differences of opinion, we are in agreement on certain general principles. At least, let's make a try at it.

Is that agreeable to you, Mr. Thornton? You made the motion, and I am trying to steer it away for the moment.

**Mr. THORNTON.** I stand by your ruling, so long as we have the opportunity to be heard on the question of these final findings.

**Dr. WOLMAN.** I give the audience, of course, no feeling that we have any great optimism as to how we are going to reconcile the types of differences that you promptly point out. We are going to make a try at it. We may end up, as so often is the case, with certain agreed principles which we hope will be useful and point out, in fact, where there are significant departures in the panel from such principles, if there are such departures.

I recognize next Mr. Robert W. A. Rodger (New England Interstate Water Pollution Commission).

**Mr. RODGER.** Mr. Chairman, distinguished members of Panel III, ladies and gentlemen. I regard it as not only a great privilege but as an even greater opportunity to call the attention of this group of outstanding experts on the problems of pollution control, to a well seasoned financial mechanism which can be used successfully in the financing of bond issues by municipalities and States for sanitary facilities. As we all agree, money is the root of the sewage problem, and the principle of Federal and State insurance should take a prominent place in all our thinking and discussions on that problem.

The New Frontier of the Democratic Party is visualized as a nation of unpolluted rivers, with an abundance of clean, usable water, our most used raw material. It is estimated that the cost of this blessed state will be from $12 to $15 billions. This is a massive sum of money. The question arises as to who will pay the bill, the municipalities, the States or the Federal Government? The trend of public opinion appears to be in the direction of a division of the responsibility between the three parties concerned.

Until the early 1930's, when the New Deal made a few grants-in-aid on municipal projects providing sanitary facilities, the financial responsibility had always been viewed solely as a community responsibility. However, the trend ever since the New Deal grants were made, has been to regard it as a joint responsibility of the municipal, State, and Federal Governments. In my own State of Vermont, the costs are divided unevenly in three ways—50 percent community, 20 percent State, and 30 percent Federal.

Many factors are responsible for the development of a policy of joint responsibility. One is the realization that the problem is no longer local, as it was in the horse and buggy days, but national in its scope and effects. Another factor has been the success attending the Federal grants-in-aid policy. Still another is the knowledge that for every $1 expended by the Federal Government, the States and municipalities have expended more than $4. Cooperation between the three parties concerned has paid off handsomely, and there is no great movement for its discontinuance. In my opinion, the day will soon come when each party will be held responsible for one-third of a project's cost.

We have seen that under the best of auspices, because of the tremendous demands on the Federal purse, Federal cash grants-in-aid must be limited despite the merits of a project. Even big spenders in Congress are well aware of this fact. If the Federal Government is to bear its full share of responsibility, its income must be augmented by either an increase in taxes, or by the creation of some new financial mechanism capable of caring for the demands.

This is no new dilemma which will face President Kennedy and the 87th Congress. President Roosevelt faced an identical problem in 1934 when there was a dearth of Federal income for financing his vast housing plans. But he found a way around that impasse by using a then new and unique financial mechanism, namely, Federal insurance of mortgages and bond issues on housing loans. The principle involved was the acceptance by the Federal Government of a contingent liability on sound loans. The history of the FHA proves that it was a sound policy. Indeed, the FHA has never cost the taxpayer a nickel, and it now has on hand from earnings the sum of nearly $700 millions. It can be applied with equal success and security in the case of bond issues on projects providing sanitary facilities.

Federal insurance of bond issues lulled the fears of investment bankers and induced them to release a veritable flood of gold for new construction. It also enabled projects to obtain minimum rates of interest and long terms for amortization, resulting in tremendous savings. I wonder how many people here today realize that a saving of 1 percent interest over a 30-year period is nearly the equivalent of a 30 percent Federal cash grant-in-aid.

Additional proof of the merits of the insurance principle is the tremendous savings created by State insurance of bond issues for sanitary purposes. For example, the State of New Hampshire guarantees all bond issues on sewage projects. Consequently, projects built in New Hampshire pay from one-half to one percent less interest than do similar projects built just over the State line in Vermont, where the State advances only 20 percent of a project cost.

Not all States have the high financial rating of New Hampshire and Vermont, and the value of State insurance would vary with the credit rating of any particular State. Furthermore, it would take a long time to persuade each and every State to provide insurance legislation. Therefore, I favor Federal insurance for quick results and uniform values.

Another factor favoring the choice of Federal insurance is the fact that a large percentage of the towns needing sewage works are very small villages. Approximately 75 percent of the communities requiring sewage works in the Nation have populations of less than 2,500 inhabitants. Almost without exception they are poor and in need of financial assistance in the execution of big projects. In many cases new legislation will be necessary to enable them to build. Not many States have enabling acts such as we have in Vermont, which permit towns to finance projects outside the limits of their bonded inbebtedness with revenue bonds, in the same way in which all public utilities are financed, using the plant and service charges as security for the loan.

In conclusion, while the grants-in-aid policy would appear to be firmly fixed, it is quite possible that when the superior advantages, to all concerned, of Federal insurance becomes apparent, it will gradually phase out the grants policy. This thought is based on the conviction that self-sustaining, self-liquidating projects need no help from the Federal Government, other than the bond guarantee. When Congress becomes convinced of this, it will quickly relieve the Government of this massive financial burden.

Since my allotted time has expired, for the benefit of anyone interested in this subject, I am attaching for the record a more detailed statement which I delivered at the hearings of the Senate Select Committee on National Water Resources, held in Boston on December 8, 1959. You will also find attached for the record, a copy of Congressman Broomfield's bill, H.R. 2733, which provides for Federal insurance of bond issues by States and municipalities for water and sanitary facilities. Congressman Broomfield believes that a Federal guarantee of municipal and State bond issues for sanitary purposes will galvanize the flow of money from investment banking sources into that field.

With every municipality, State and pressure group in the Nation running to Washington for loans and grants-in-aid, the financial resources of the Federal Government are being strained to the utmost to meet these demands for help. Most of the requests for aid are of the type formerly satisfied by investment banking institutions. But the substitution of Federal spending for private investment has had the bad effect of driving private credit from many areas where it is urgently needed and suitable.

Many economists predict that unless all Federal spending for massive domestic projects is restricted to those for which no suitable machinery can be developed for private investment, this Nation will soon be operating under a form of Federal capitalism, typical of the welfare state or the system in Russia, where allocations of capital for all projects are made by the Central Planning Board.

Therefore, it is welcome news that a bill was recently introduced in Congress which provides machinery well calculated to relieve the Federal Government of the necessity of making any greater cash outlays for the construction of sewage treatment projects than it is now providing.

The bill, H.R. 2733, was sponsored by Congressman William S. Broomfield, of Michigan. It provides for a financial mechanism whereby the Housing and Home Finance Administrator may guarantee (insure) bond issues made by municipalities and States for water supply systems and all types of sanitary facilities, including sewer systems and sewage treatment plants.

The principle involved in the bill is not new. The substitution of a Federal guarantee of bond issues for outright Federal grants was first tested by the Federal Housing Authority in the 1930's and utilized ever since. In practice, it proved to be a far more effective instrument for the revival of the building industry than had all the loans and grants made for that purpose by Washington prior to its adoption.

The long history of the FHA has demonstrated that the Government assumes practically no risk when it guarantees loans made subject to the highest standards of investment and construction. It is carrying out a safe policy—assuming a contingent liability on a sound loan.

Probably the most important deduction to be drawn from the FHA experience with insured loans is the lesson that Federal financial assistance is not limited to outright cash handouts. It has demonstrated beyond question that massive domestic projects, when capable of operating successfully on the revenue they collect on a *quid pro quo* basis for services rendered for goods provided, can be financed by private credit when suitable machinery is developed. Sewage treatment plants are typical of the sort of projects we have in mind. Our experience with guaranteed FHA mortgage loans has direct bearing on what may be expected in the case of guaranteed bond issues for sanitary purposes.

Although sewage works are not housing, in many ways they fit the same category. Each typifies a capital investment which is self-sustaining and self-liquidating from the revenues derived from the sale of services rendered—sewer service charges or rentals. Sewage works are a form of public utility which is financed, owned and operated by municipalities, and occasionally by private investors.

If there are still some who harbor any lingering doubts about the advisability of the Federal Government assuming so vast a contingent liability, they may find assurance in the following facts.

Sewage works provide a much safer investment than the most conservatively financed housing loans insured by the FHA because no promotion fees and excessive builders' profits are included in the cost. Absent too are the customary bonuses, discounts, and subordination features connected with housing projects. Furthermore, the revenues from sewage projects are always based on minimum estimates sufficient only to carry the fixed charges, cost of operation and maintenance, and set up adequate reserves for depreciation and obsolescence. In other words, they are rigged to meet every storm of financial adversity.

Additional security is afforded by making the bonds an obligation of the municipal corporation and/or a mortgage on the treatment plant, sewer service charges, and sewer lines. Also, from 30 to 50 percent of the total cost of projects is written off at once by the Federal and State grants-in-aid. Great security for earnings is gained by the practice of including the sewer service charges in the water bill, which must be paid or the utility can enforce collection by shutting off the water.

When to all these valuable considerations we add the Federal guarantee, a powerful inducement is provided to attract private credit into this field of investment. Just how great and immediate will be this response we have no way of knowing until it is tried out. It could very well be a slow process because conditions are much different today than in the 1930's when the guarantee principle was first introduced.

We were then at the bottom of a great depression. Federal income had reached its lowest point. The building industry was gasping for life. The investment banking institutions were bulging at the seams with idle gold. It presented a combination of forces which proved ideal for the successful trial of the guarantee principle.

In contrast, today, Federal revenues from taxes are the highest in our history. But to offset this favorable factor, demands on the Federal purse have reached an all-time peak because of the cold war and liabilities for past commitments and going expense. In consequence, there is little money available in Washington with which to finance the massive domestic projects on the national agenda.

There is still a large area of this sewage program not covered by Federal grants to which the insurance principle is applicable. For example, there is the 70 percent balance (50 percent in some States which grant 20 percent) above the 30 percent Federal grant-in-aid. The municipalities are responsible for this amount and Federal insurance of their bond issues should prove most helpful by way of lower rates of interest and longer terms for amortization. Another area is the sewer systems of municipalities. Many of them are very old and need replacing. Many of the towns needing disposal plants have no sewer system—only cesspools and septic tanks. The Federal grant-in-aid for sewage treatment plants does not cover this expensive problem. It must be financed with a separate bond issue, which will be helped by a Federal guarantee.

The Broomfield bill, H.R. 2733, was introduced in Congress on January 19, 1959. Since that date it has been held without action by the House Committee on Banking and Currency. Anyone interested in a good, sound piece of legislation, which will benefit the development and conservation of our natural resources without making a cash drain on the Federal Treasury should write at once to his Representative in Washington in its favor.

[H.R. 2733, 86th Cong., 1st sess.]

A BILL To provide for a program whereby the Federal Government may guarantee bonds issued by States and municipalities in carrying out construction programs for certain public sanitary facilities

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That as used in this Act—

(1) The term "public sanitary facilities" means—

(A) water supply systems, including all plants, works, instrumentalities, and properties, used or useful in connection with obtaining a water supply, and the treatment or distribution of water;

(B) sewage disposal systems, including sanitary sewers, combined sanitary and storm sewers, plants, works, instrumentalities, and properties, used or useful in connection with the collection, treatment, or disposal of sewage, storm water from combined systems, sanitary sewage, or industrial wastes; and

(C) garbage and refuse disposal systems, including all plants, works, instrumentalities, and properties, used or useful in connection with the collection and disposal of garbage or refuse.

(2) The term "State" includes a State, the District of Columbia, Hawaii, Puerto Rico, and the Virgin Islands;

(3) The term "municipality" includes a city, town, borough, county, parish, district, or other public body created by or pursuant to State law and having jurisdiction over any public sanitary facilities, as defined in paragraph (1) of this section; and

(4) The term "Administrator" means the Housing and Home Finance Administrator.

SEC. 2. It is hereby declared to be the policy of the Congress to recognize, preserve, and protect the primary responsibilities and rights of the States in preventing and controlling water pollution and in providing public sanitary facilities for the health and welfare of their citizens. It is the purpose of this Act to assist the States in carrying out such activities through the establishment of an adequate Federal support program for bonds issued by States or municipalities. To this end the Housing and Home Finance Administrator shall, under regulations prescribed by him, guarantee certain bonds issued by any State or municipality for the construction of public sanitary facilities.

SEC. 3. Any State or municipality desiring to avail itself of the benefits of this Act shall make application in writing to the Administrator stating—

(1) that the State or municipality desires to issue bonds to obtain funds for the construction of public sanitary facilities;

(2) a description of the proposed public sanitary facilities containing such information with respect to construction plans and costs as the Administrator may prescribe;

(3) population figures indicating, with respect to such State or municipality, the population for ten years preceding the date of such application, the population on the date of such application, and reliable projected population figures for twenty years after the date of such application;

(4) taxable property valuation figures indicating, with respect to such State or municipality, the total taxable property values for ten years preceding the date of such application, on the date of such application, and reliable estimates of such values for twenty years after the date of such application;

(5) the total outstanding per capita indebtedness (exclusive of any indebtedness for school purposes) of such State or municipality applicable to the district or area to be served by the proposed public sanitary facilities;

(6) such other data as the State or municipality may deem pertinent to indicate future ability to meet its obligations; and

(7) such other information as the Administrator may deem appropriate to enable him to carry out the provisions of this Act.

Sec. 4. The Administrator may, after reviewing the information contained in any application submitted under section 3, approve any such application, except that he shall not approve any such application—

(1) unless the bonds described therein are to be issued within three years after the approval of such application and will mature not more than fifty years from the date of issue;

(2) unless the State or municipality concerned agrees to pay the United States an amount equal to one-fourth of one per centum of the total maturity value of such bond issue to defray Federal administrative costs of the bond guarantee program provided by this Act;

(3) if, in the opinion of the Administrator, the State or municipality concerned will be unable, within the ten-year period beginning on the date of issue of the bonds involved, to meet at least 60 per centum of its financial obligations on such bonds; and

(4) unless the State or municipality concerned agrees to repay to the United States any amount paid by the United States on account of a default on the part of such State or municipality with respect to any payment of principal or interest, on bonds guaranteed by the Administrator, during the ten-year period beginning on the date of the issue of such bonds, plus interest at the rate of 6 per centum per annum from the date of the payment of any such amount by the United States to the date of repayment by such State or municipality within the twenty-year period beginning on the date of issue of such bonds.

Sec. 5. The Administrator shall, with respect to each application approved by him under this Act, guarantee the bonds issued by the State or municipality in accordance with such approved application and, as evidence of such guarantee, the Administrator shall issue to the State or municipality concerned a certificate pledging the full faith and credit of the United States for the payment of the principal and interest on the bonds described in such certificate, during the ten-year period beginning on the date of issue of such bonds, and specifying the total value of the bonds, and the maximum interest rate thereon, included within the terms of such certificate.

**Dr. WOLMAN.** It is interesting, I think, that Vermont in this case is not debating very much with the gentlemen from Massachusetts on this question of jurisdiction. This is particularly interesting to an observer or listener here that the individual States and localities edge into the Federal Treasury by various routes and in various amounts. And I suppose if I were objective about this, this is a very interesting commentary on the whole situation we are trying to resolve. Where the argument begins, apparently, or ends, is how much you edge in and, in turn, of course, what price you pay for edging in on its fiscal resources. And I assure you that you have to pay a price to any banker upon whom you call for additional amounts of money.

This is not taking sides. I have not said that 30 percent is virtuous and 35 percent to the Federal Government is sinful. I am merely pointing out what I am listening to during today's conversation.

I rather suspect that the State and local groups will have to make up their minds as to how less than virtuous they want to remain. This is an observation which crops out of almost all of the discussions. I pointed it out in my opening remarks. One of the problems you are going to be confronted with is where you are going to get painless abstraction of money from some of the bodies. I recall again, since this morning is a long time away, that all of these moneys of which we are talking come out of the same pockets. There are no substitutes for those.

The allocation of them is where the machinery becomes a little smoother in one direction or another. And this is what I suppose every advocate of State and local and Federal responsibility is talking about—how easily and how smoothly can he get the money without anybody being aware that he is giving up either local or Federal responsibility. I am being as realistic as I know how.

I want to call on Mr. Charles H. Callison now who has also requested to be heard from the floor. He represents the National Audubon Society, New York.

**Mr. CALLISON.** I wish to comment on the point of view expressed in this Conference by such able spokesmen as Mr. Leonard Pasek, in this panel, and Mr. Albert Forster, in the opening plenary session, and by others, that waste disposal is a proper use, and even properly the exclusive use, of certain rivers, and that this "principle" should be recognized in our national policy on pollution.

May I point out the fatal danger, as well as the basic fallacy, in this contention? To assert that a given stream should be dedicated to use as a cesspool is to say that we recognize as correct and proper the polluted condition of many streams today. If it has been proper, as well as convenient, to permit one municipality and its community of industry to dump their untreated wastes into the river in the past, there is no logical way we can say that another growing city and new industrial plants in another location should not likewise use the stream that flows by them—particularly if the relationship between cities and their industries is a competitive one. It is a policy of defeat and retreat which the public cannot accept and the Nation cannot afford.

There is another reason why the industrial firm that builds its future plans on this policy is merely hiding its head in the sand. The use of streams for waste disposal—if this can be called a use—is now in violent collision with other public needs, needs growing out of our population explosion, our growing economy, and increasing urbanization. The harsh fact is there are not enough streams now to go around. The river now being polluted is needed, and needed badly, for other industrial uses requiring clean water, for recreation, for agriculture, for fish and wildlife production. Your own community needs the flood plain and the river banks for parks and new housing sites—and to so use the flood plain requires cleaning up the stench and eyesores of pollution.

The point is simply this: The people of America will no longer look upon a polluted river as well used. When they look at the river they see boating and swimming and fishing and streamside picnicking opportunities—if only the pollution were cleaned up.

And the people know it can be cleaned up—greatly improved, if not completely cleaned up. The public cannot believe that America's industrial technology, which has performed miracles in production, cannot also solve the problems of waste treatment. The public is not likely to settle for less.

In conclusion I should like to subscribe to and endorse the closing remarks of Mr. Robert F. Boger in which he asserted the futility and the risks of trying to solve certain not so local aspects of water pollution in any way except by dealing the Federal Government a strong regulatory and enforcement hand in the national effort. A strong Federal hand is absolutely essential to progress in cleaning up what has been correctly referred to in this Conference as this "national disgrace."

We also believe that most of the States need stronger regulatory and enforcement powers than they now possess to deal with water pollution.

**Dr. WOLMAN.** I don't know whether Mr. Pasek wants a minute to remind Mr. Callison or anyone else in the audience as to what you actually said about the use of streams for waste disposal.

**Mr. PASEK.** I would only suggest that a clear reading of my paper does not indicate that industry advocates streams be used solely as carriers of pollutants. This is only a comment that was made about one river and one community's decision or one area of that decision, and this was not a promulgation to be considered for all of our streams.

**Mr. ADAMS.** This question is for Mr. Lynch and was asked by Mr. Jack T. Garrett, of Monsanto Chemical Co.: ***"How does industry get the press to report positive progress in pollution abatement?***

There is another reason why the industrial firm that builds its future plans on this policy is merely hiding its head in the sand. The use of streams for waste disposal—if this can be called a use—is now in violent collision with other public needs, needs growing out of our population explosion, our growing economy, and increasing urbanization. The harsh fact is there are not enough streams now to go around. The river now being polluted is needed, and needed badly, for other industrial uses requiring clean water, for recreation, for agriculture, for fish and wildlife production. Your own community needs the flood plain and the river banks for parks and new housing sites—and to so use the flood plain requires cleaning up the stench and eyesores of pollution.

The point is simply this: The people of America will no longer look upon a polluted river as well used. When they look at the river they see boating and swimming and fishing and streamside picnicking opportunities—if only the pollution were cleaned up.

And the people know it can be cleaned up—greatly improved, if not completely cleaned up. The public cannot believe that America's industrial technology, which has performed miracles in production, cannot also solve the problems of waste treatment. The public is not likely to settle for less.

In conclusion I should like to subscribe to and endorse the closing remarks of Mr. Robert F. Boger in which he asserted the futility and the risks of trying to solve certain not so local aspects of water pollution in any way except by dealing the Federal Government a strong regulatory and enforcement hand in the national effort. A strong Federal hand is absolutely essential to progress in cleaning up what has been correctly referred to in this Conference as this "national disgrace."

We also believe that most of the States need stronger regulatory and enforcement powers than they now possess to deal with water pollution.

**Dr. WOLMAN.** I don't know whether Mr. Pasek wants a minute to remind Mr. Callison or anyone else in the audience as to what you actually said about the use of streams for waste disposal.

**Mr. PASEK.** I would only suggest that a clear reading of my paper does not indicate that industry advocates streams be used solely as carriers of pollutants. This is only a comment that was made about one river and one community's decision or one area of that decision, and this was not a promulgation to be considered for all of our streams.

**Mr. ADAMS.** This question is for Mr. Lynch and was asked by Mr. Jack T. Garrett, of Monsanto Chemical Co.: ***"How does industry get the press to report positive progress in pollution abatement?***

***We have been told by reputable newspaper people that this is not news and seldom is any mention made of such accomplishments."***

**Mr. LYNCH.** I can only speak for one newspaper, and that is the one I work for and I do not have to speak for it myself because there are representatives here of the pulp and paper industry, which probably empties into the waters of Wisconsin in total quantity more polluting material than any other industry. They will tell you that while we have put pressure on them over the years to clean up, we have regularly published their efforts to do so. You are at liberty to ask one of them to stand up, and they will tell you the same thing.

I would like to say one thing. That is something that newspapers should do generally, because when they take upon themselves the right to criticize they should also recognize for themselves the duty of publicizing the remedies.

**Mr. ADAMS.** Mrs. Whittemore, to you is put this question by Mr. C. R. Walbridge, of the Allied Chemical Corp.: ***"Does the League of Women Voters of the United States favor greater Federal control in the water pollution field than is provided in Public Law 660?"***

**Mrs. WHITTEMORE.** What the League of Women Voters is after as a citizens' group is pollution abatement. It has been our observation that municipalities do not clean up, do not vote the treatment plants, without the State breathing pretty heavily down their necks. It has also been our observation that the State, not all States, do not have in order their organization for pollution control for the enforcement of pollution abatement. We believe that they will be more likely to put their State houses in order (the State legislature will be more likely to do this) if the Federal Government is known to be in the background with more power, more clearly defined power of enforcement.

**Mr. ADAMS.** This is a question for Mr. Curley, but in his absence I will direct it to Senator Whitfield.

Mr. R. D. Kogler, of the Chamber of Commerce and Lions Club of Moundsville, W. Va., wants to know: ***"Since water pollution control equipment is considered by many State and Federal officials as necessary for new and existing industries, why then does not the Bureau of Internal Revenue allow such expenditures as necessary business expenses and not as currently done by capitalization over an extended time period?"***

**SENATOR WHITFIELD.** I, of course, am not an internal revenue agent representative, but I approach it this way, briefly.

You heard me say this morning that our most precious commodity is water. Well, I want to probably surprise some of the business people, particularly big business, by saying our second most precious commodity is industry. That is why we have to protect industry sometimes from its folly.

Therefore, I am all in favor when you reach a marginal city or a marginal industry that they should be helped. When it comes to the cities, the ratio of course is open to discussion, and you have heard this here this afternoon.

I think a national policy is in reality a National, State, and municipal policy. Therefore, I do not think it is socialism to help a marginal municipality nor even to help a marginal industry. There are some industries that if we tried to enforce even a reasonable pollution law on them they could not stand it. Therefore, I think we should help them.

We think nothing of letting our big industries write off a munitions plant in time of war in short order. Let us take it in those terms. I do not know why this is not done, but I certainly have no objection to helping those who need help, because this is war that we are constantly carrying on. Let us carry that away from here with us. Pollution and fighting pollution is war, a war against unseen things, against bacilli.

**Mr. ADAMS.** Now, we have a question for Mr. Boger from Edward J. Cleary of ORSANCO: ***"You suggest the earmarking of specific taxes, notably from Federal licensing of pleasure boats and sale of fuel to all waterborne craft, for pollution control purposes. Whom do you propose should receive these earmarked funds, Federal, State, or municipal agencies, and for what purpose would the money be used—construction, research, or enforcement?"***

**Mr. BOGER.** I would like to reverse the question, that is to say, I would like to answer the second part of it first.

I think the money should be spent for construction. Money needed for research and enforcement I think should come from the general fund.

Now, who should receive these earmarked taxes? I am not certain it makes a great deal of difference. Various Federal taxes are collected in various ways. I am inclined to believe, pending any expert analysis of the situation, that such taxes should be received by the States much the same way as Federal estate taxes.

**Mr. ADAMS.** I have a short statement by Charles B. Kaiser, Jr., general counsel, Metropolitan St. Louis Sewer District. He would like to recommend that "this Conference examine the Federal grants-in-aid to municipalities and proposes that these grants-in-aid be based on the flat percent of construction cost, or at least pay the standard engineering fees for the project."

Mr. Chairman, I should think that should go to the Congressional committee later on.

Now, we have a question for Mr. Wilson: ***"Doesn't the fact that, as you state, water pollution control has gone far beyond the question of public health and has involved the interests of agriculture, industry, and recreation, suggest that at the Federal level the joint judgments of the Soil Conservation Service, the Commerce Department, U.S. Geological Survey, and so forth, be sought?"***

**Mr. WILSON.** All I have to say is that I think it is a good idea, and I wonder if it hasn't already been recognized by the present Water Pollution Control Advisory Board. I do not know just exactly to what extent they consult all the other agencies involved, but I believe that they do try to get in touch with all those that are mentioned and others that may be concerned. Certainly it is a good idea.

**Mr. ADAMS.** This is a question for Mr. Sanders submitted by J. H. Cornell on behalf of the International Association of Game, Fish, and Conservation Commissioners: ***"What is the practical danger of total surrender of Federal authority to the 50 States in the field of pollution control?"***

**Mr. SANDERS.** In the first place, let me say that I do not believe that there is any danger of the surrender of the problem to the 50 States—nor that we will actually come to face this danger in the next 4 years. We have not faced it in fact to my knowledge since 1948. The surrender of any degree of Federal responsibility with respect to the laggard States has very little likelihood of development, and I am not so sure it would be a good idea in the first place. I recall very distinctly when Senator Whitfield and I served together in the North Carolina Legislature that the primary reason our State Stream Sanitation Act passed in 1951 was the fear of the wrath to come or that would otherwise come. And the wrath that legislators were speaking about was the Federal Government's total occupation of the particular field.

There are local presentations, or aspects, or particular water problems, but when you endeavor to surrender the entire resource, if you please, to any particular segment of government, rather than placing responsibility and authority and making a commitment at all levels, you ignore the overriding reality that the problem of water presents itself as a trinity to all three, Federal, State, and local governments, and should be met accordingly.

When you break away, therefore, and give up a field—this is a strange suggestion, that the Federal Government give up a field because ordinarily, they take over a field and the States immediately vacate it—but this will not work here. If you will permit me to quote a little loosely from St. Paul, I think here we must take on the whole armor of God. I believe that is it. I do not think we get anywhere when we bog down in jurisdictional controversies between Federal, State, and local governments. I think the job is too big for any one of the three. I am convinced the job is not too big for all three, with the support of an enlightened industry, with the support and enthusiasm of an enlightened citizenry.

**Mr. ADAMS.** Jack T. Garrett of the National Technical Task Committee on Industrial Wastes has asked that this 10-page description of the organization and their activities be made a part of the record of this conference. We would recommend that it be included unless there is serious objection.

# Where Does Industry Stand in Water Pollution Control?

By A. J. Steffen

Director of Sanitary Engineering, Wilson & Co., Chicago, Ill., and Chairman, National Technical Task Committee on Industrial Wastes (presented at 33d Annual Meeting of Water Pollution Control Federation, October 3, 1960, Phildelphia, Pa.)

The question posed in the title of this paper can best be answered by evaluting the past, determining industry's position in the present, and pointing up trends that are shaping the future. This is an ambitious task, especially in a field so lacking in accurate basic data.

In dealing with this subject, I shall speak about industry, but not for it. It would be presumptuous for anyone to speak for all of industry on this broad and somewhat controversial question. However, sanitary engineers in industry as well as many officials of State water-pollution control agencies have helped develop this discussion by providing valuable background data.

## Evaluation of Pollution

Dr. Richard D. Hoak (*1*) presents a clear-cut definition of pollution: "Pollution is the discharge of material that unreasonably impairs the quality of water for maximum beneficial use in the overall public interest." However, Dr. Hoak hastens to add, "The difficulty with the simple definition of pollution just given lies in our inability to assign a quantitative meaning to unreasonable impairment of water quality.

The stream sanitation picture is made up of many individual mosaics—individual reaches of streams where municipal and industrial effluents are discharged. The determination that any effluents are polluting the stream depends upon whether the stream can accept such effluents without impairing the quality of the water for maximum beneficial use in the public interest. Regulatory agencies must determine the quality limits for the effluents in question, based upon the needs demonstrated by the various competing uses of the stream.

In 1938, Streeter (*2*) set down the principles of evaluation of stream quality in these words: "To solve this problem (of evaluating pollution) rationally, it is necessary to analyze it from the standpoint of the relative effects of various up-stream population groups on conditions of pollution at the particular point of interest downstream." Note that we must deal with the effect of the effluent upon the stream, not the effluent itself.

This principle seems relatively elementary, but it warrants reemphasis, since some analysts have, in recent years, attempted to evaluate our national progress in pollution control by citing totals of biological chemical oxygen demand or population equivalent discharge. This approach does not measure pollution. It measures effluents rather than their effect on the stream, and it classifies as pollution increments the thousands of municipal and industrial effluents discharged in full compliance with all regulatory requirements.

In assigning a quantitative meaning to impairment of water quality in a specific reach of stream, the economic value of each use of the stream water is an important, but often neglected ingredient. In an evaluation of costs versus benefits in stream pollution control, the Food Research Institute (*3*) of Stanford University under contract with the U.S. Public Health Service concludes that the pollution control administrator should "study and reflect upon each individual case, in the light of such general guidance as the economist can offer, and such factual information as he himself can muster." Edward J. Cleary, executive director and chief engineer of Orsanco, expressed this philosophy more directly a few years ago when, in discussing the substantial cost of waste control in industry, he stated, "I display the dollar sign simply as a reminder that pollution control is a costly proposition and that no one can benefit from unnecessary restriction of waste discharge. Thus, I plead that we embrace the concept that the quality conditions to be maintained in a stream should be related to use requirements. On that basis we have the opportunity to develop a pollution control program that is practicable, reasonable, and rational."

## Development of Basic Data on Industrial Waste and Water Use

Basic data on the effects of industrial wastes on water pollution for any period—past, present, and future—are very limited. A survey made in 1950 by the Conservation Foundation and the National Association of Manufacturers, published under the title "Water in Industry," presents a substantial amount of data for that year, but the survey was centered around industrial water supplies with relatively limited information on waste disposal.

Currently, a survey is underway known as the industrial water use questionnaire sponsored by the Conservation Foundation, the National Association of Manufacturers, the Chamber of Commerce of the United States, and the National Technical Task Committee on Industrial Wastes, to obtain information on industrial wastes and industrial water use. This survey has been launched concurrently with the 1960Census of Manufacturers, and augments the data to be obtained in the latter. Associations represented in the task committee are cooperating by clearing the questionnaires through their offices to their membership. A report based on the results will be published in 1961, and is expected to yield meaningful data on industrial water use, conservation, and disposal, and with the information obtained in the 1950 survey, will tell some thing about the past decade and indicate trends and needs for the future.

## An Estimate of the Situation

The report on the industrial water use questionnaire will supply some of the answers a year from now but how shall we estimate progress in pollution control now?

A State director of pollution control suggested that industry's position could be explored by considering the number of cases corrected and the number of cases or treatment needs pending in any selected representative area. Since a case or problem (be it of municipal or industrial origin) is a problem because of its effect upon a stream, it is an element in pollution control and can reflect stream improvement far better than effluent data. Using this approach, a questionnaire was developed (fig. 1), limited to three questions, for distribution to a few State stream pollution control administrators. Beginning with this modest approach, the evaluation finally covered the entire United States with the exception of eight States: Alaska, Arizona, Hawaii, Idaho, Montana, Nevada, New Mexico, and Wyoming. Of the 42 questionnaires sent out, 38 sets of data and questionnaires were returned with sufficient information to be tabulated (table 1). (See p. 405.)

It was emphasized to the respondents that where accurate data were not available, an estimate would be satisfactory, since the estimate of the State administrator and his staff would be an authoritative evaluation. The total data from 26 States were summarized. All other replies omitted some data or deviated from the pattern of one or more of the questions. Respondents were encouraged to submit data in any form they wished if their records were not in such form as to facilitate answers to the questions as stated. This yielded an extensive bibliography which aided materially in developing background information for this study.

Since a large portion of the tabulated data is based on estimates, the summarized statistics are presented only as guidelines. However, recognizing that an estimate would tend to be uniformly high or low, it is reasonable to expect percentages calculated from the data to be fairly representative of actual conditions.

An analysis of the totals for the 26 States indicates a 74.5-percent increase in municipal treatment facilities and a 64-percent increase in industrial waste treatment in the past decade. During the same period there was a decrease in needs of 36.5 percent among municipalities and 44 percent among industries. Recognizing that a portion of the municipal gain is also a gain in industrial waste control for those industries discharging into municipal sewers, it is evident that there has been substantial progress in the control of industrial wastes by treatment. It will be noted that industries show less increase in waste treatment, but a greater decrease in needs. This reflects a trend toward consolidation of small plants and a movement of industries into cities, trends that reduce needs in industrial waste treatment without building separate industrial waste treatment plants.

The proportion of treatment facilities as against the total requirements (i.e., col. 1 divided by (col. 1 plus col. 2)) presents some interesting figures. In 1950, 48.5 percent of the municipalities and 46.5 percent of the industries that needed treatment had treatment facilities. In 1960 these figures rose to 72.2 percent of the municipalities and 71.7 percent of the industries. Similar data for the Orsanco Drainage District show 48.4 percent of the municipalities, and 87.9 percent of the industries with waste control facilities in 1959. Just 7 years earlier Orsanco reported that only 26.5 percent of the municipalities and 54.5 percent of the industries had facilities in operation. Although many of the problems remaining after the first years of effort in Orsanco and other postwar stream improvement programs are especially difficult to solve, the administrators of these programs can point to the record with justifiable pride.

## Progress in Industrial Wastes Conservation

The record that no survey can show is the amount of water pollution control effected by waste conservation within industry. Waste conservation data are difficult to collect and are not readily summarized, but many examples can be cited.

There is the oft-repeated success story of the Fontana, Calif., steel plant which uses 1,300 gallons of water per ton of steel produced, while some of the older eastern mills are using 65,000 gallons per ton. The average fuel electric powerplant uses 40 percent less water per kilowatt-hour of electricity produced than in 1940, even without recirculation. I have seen a meatpacking plant reduce its waste flow by 20 percent during a period of increasing kill. A week's work in a cheese plant and several thousand dollars of waste-saving equipment reduced the b.o.d. of the total plant wastes by 50 percent. A manufacturer (*4*) of penicillin reports a b.o.d. reduction from 9.1 pounds per pound of product without recovery down to 1.4 pounds with in-plant recovery. A distillery (*4*) reports over 50-percent reduction in b.o.d. by in-plant waste saving over an 8-year period.

Waste conservation takes many forms and is as complex as industry itself. It may involve a change in a process to eliminate a troublesome waste; it may mean developing new products to utilize a waste; it may mean incineration of wastes with heat recovered as a byproduct; it may be recirculation of the water, or reuse after treatment. According to the 1954 U.S. Census of Manufacturers, industrial water requirements would have doubled if none had been recirculated or reused.

This part of industry's water-pollution control program begins by installing a consciousness for waste conservation in management and supervisory personnel at all levels. The sanitary engineer in industry has a selling job to do and his approach is often unique. He uses motion picture and slide presentations, chalk talks, and group discussions, progress contests between plants, in-plant conservation committees, individual merit awards—one firm distributed pencils with waste conservation slogans on them. While selling waste conservation, the engineer must implement the effort by providing background information, waste surveys, and specific answers. He must furnish information on everything from self-closing valves for drinking fountains to entrainment separators on vacuum pans. Much has been done in waste conservation much is being done, and more needs to be done.

## Industrial Wastes Research

Millions of dollars are being spent by industry in industrial waste research, much of it on utilization and conservation of wastes. This cost rarely appears in the records as research in pollution control because it is usually classified as product research.

In waste treatment, research industry has certain inherent advantages over the municipal sewage field. For example, industrial waste treatment studies can be conducted on a semiplant scale, and, if need be on a full-scale trial and error basis—procedures generally not adaptable to municipal financing. Such studies have been stimulated in the postwar years by the work of industrial chemists and process engineers who have infiltered the sanitary engineering field. They tackle each problem as a process problem, often breaking away from conventional treatment practices to develop entirely new processes.

These methods have led to significant breakthroughs in industrial waste treatment—microbiological oxidation, disposal by irrigation, development of synthetic trickling filter media, the anaerobic contact process, air flotation, the use of ion exchange for removing dissolved ingredients, and disposal of sludge by wet oxidation, to name a few. Some of these processes, developed in the industrial field, have been adapted to the treatment of municipal sewage, notably microbiological oxidation and sludge disposal by wet combustion.

In the past, many of these discoveries went unheralded because they were developed for a specific problem at a specified plant. In recent years, however, the National Technical Task Committee on Industrial Wastes has served as a center for an exchange of information, principally through annual progress reports developed by each industry segment prior to every annual meeting. Through this channel, new developments in one industry have found applications in other industries.

## Trends Shaping the Future

Now that we have looked at the past and seen progress and positioned ourselves in the present, what about the future?

The limited basic data on industrial waste control and the many variables that influence changes in the industrial complex do not permit a statistical evaluation of the future. However, in an unpublished survey among representatives of industry conducted in 1959 by George E. Symons, 23 respondents predicted an average of 100-percent growth in industrial waste treatment by 1975, using 1958 as a base. Whereas this is obviously not a statistical projection, it is an estimate of the situation by men who know the field and so sheds light on the future.

We can also learn something about the future by observing the trends that are shaping it. Let us examine a few:

(1) Integration of industrial waste management with production

The brightest star on the horizon is the increasing recognition among industrial leadership, that disposing of the waste is part of the production job. No longer is the wastes management engineer an unwanted bystander when new plants and new processes are developed. Now he is a full partner in planning for process changes, in new products development, and in new plant design. *This is a trend shaping the future.*

(2) National technical task committee on industrial wastes

This group was organized in 1950 as an arm of the President's Water Pollution Control Advisory Board to assist the Public Health Service on industrial waste matters, and to facilitate an exchange of information in this field. It now consists of 65 members and alternates representing 34 industries. Membership is diversified to include a broad range o fspecialists to implement the committee's program. Currently, some of the activities are:

(*a*) Conducting the industrial waste and water use survey previously mentioned.

(*b*) Developing industrial waste guides to provide information to operators and managers of industrial plants, to consulting engineers, to personnel of regulatory agencies, and to superintendents of municipal treatment plants concerning the sources, characteristics, conservation procedures, and the treatment of specialized industrial wastes. In this effort the leaders in industrial waste management are pooling their information in the interests of the entire industry. Guides have been completed for the milk industry, commercial laundering, cotton textile, meat, cane sugar, byproduct coke, and wood naval stores. A guide for the potato chip industry is in print, and guides for general canning, citrus canning, fruit canning, synthetic textile, and textile printing industries are in process. These guides are published by the U.S. Department of Health, Education, and Welfare, and are distributed by the Public Health Service and the Superintendent of Documents. The task committee also publishes a News Quarterly financed by its membership for free distribution to industry and to all regulatory and educational agencies concerned with this field.

(*c*) Industry Education and Public Awareness Program: A separate subcommittee is preparing educational brochures and a TV packet, and is stimulating the development of training films.

(*d*) Research priority recommendations: A subcommittee prepares priority recommendations, outlining research projects of special interest to industry, based on an opinion poll conducted during the year.

(*e*) Manpower needs: The committee is stimulating interest and encouraging training of competent personnel for meeting needs in the industrial wastes field. In-service training programs are also developed by industries within NTTCIW and attendance at State and Federal in-service training schools is encouraged.

(*f*) Preparation of an annual progress report by each industry group: In the 10 years of the committee's life, these reports show consistent gains in the control of industrial wastes. They are published in the report of the annual meeting and are released to all interested news channels.

The aggressive work of this Task Committee is a *trend that is shaping the future.*

(3) Changes in the industrial complex

The hard facts of economics are in themselves operating to solve some industrial waste problems. Industrial plants are being outmoded at a faster rate. The average industrial plant was 27 years old 15 years ago. Today it is only 24 years old. This accelerated obsolescence offers opportunities for the introduction of modern waste conservation measures and provision of waste treatment facilities in the new plants.

The consolidation of small plants in some industries (notably the dairy and canning industries) is also a trend that is bringing with it modern waste saving features in new plants. In most cases, the consolidated plants are served by city sewers.

These changes, motivated by economics, have eliminated many potential and actual pollution problems, and will continue to do so in the years ahead.

(4) Progress through constructive water pollution control programs

This list would not be complete without a recognition of the progress in stream sanitation and industrial waste control that has been brought about by water pollution control administrators operating under reasonable and constructive regulations.

In most States stream pollution control is based upon surveys of drainage basin areas. The Delaware Water Pollution Control Policy outlines in a few concise sentences a procedure that has been found workable in many States: "The waters of the State are studied and surveyed by drainage basin areas. These investigations show the current stream condition, the wastes being discharged, the effects of these wastes, and the best uses of the streams in the various areas. Based on the best uses in the various stretches of the streams, the Commission agrees concerning the degree of treatment that is needed for each waste being discharged." The requirements are subject to review if the stream's assimilative capacity is approached or exceeded.

Industrial organizations have been actively supporting realistic practicable stream improvement programs based upon accurate appraisals of stream use. In California, for example, Mr. Rod T. Antrim, appearing in behalf of the California Conference of Industrial Associations, the California Council on Air and Water Waste Control, and the California Manufacturers Association, at a hearing in support of the State Water Pollution Control Act, stated that under this act, adopted in 1950, "the greatest progress in the history of the State has been made towards controlling water pollution." He also stated that, whereas about $300 million had been invested in municipal facilities during the 7½ years of the life of the act, industry had invested about $250 million in its own facilities. This is in addition to paying a substantial portion of the $300 million invested in municipal facilities. The 1958 Progress Report of the California Water Pollution Control Board includes a statement typical of the situation in many States:

"When the Water Pollution Control Board began operating early in 1950, many communities throughout the State were discharging untreated or inadequately treated sewage. Today, with few exceptions, the adverse conditions existing in 1950 have been satisfactorily corrected. Of even greater significance is the fact that in the past 8 years *every new major sewerage or industrial waste system has been provided with adequate treatment or disposal facilities.*"

It is also refreshing to note that a number of State Pollution Control administrators, commenting on the questionnaire, pointed out, as did F. H. Waring, State sanitary engineer of the Ohio Department of Health, that they "have accomplished the desired results by in-plant changes and changes in processes, with a minimum of waste treatment plants." Such results require a mutual understanding between industrial management and regulatory officials, an understanding that must be further strengthened for continued progress in the years ahead.

### (5) Legislation for rapid amortization of industrial waste treatment costs

Increasing interest is developing in proposed legislation, on Federal and State levels, to encourage development of industrial waste treatment works by allowing rapid amortization of such expenditures for income tax purposes. This would allow an industry to write off a nonprofit waste treatment facility to obtain some tax relief during a period of high corporate income tax. Passage of such legislation would be a definite forward trend in shaping the future.

### (6) Progress in industrial waste research

With increasing labor and material costs, research in waste conservation has become more attractive. Recent breakthroughs in waste treatment at radically lower costs than previous conventional methods are stimulating further waste treatment research. Many unsolved problems beset the research worker today, and many knotty ones will come up tomorrow. Rapid acceleration of these research efforts is essential if industry is to continue to grow to meet the needs of our increasing population and rising standard of living. The wastes research worker in industry, aided by other scientific disciplines available in his industry, and working closely with his counterparts in university and governmental research organizations, is today recognized as an important part of the industrial research team. This recognition in itself will lend impetus to industrial waste research in the years ahead.

### (7) Improvements in stream quality measurement

The quality and the quantity of data on the chemical, biological and hydraulic characteristics of our streams have improved significantly during the past decade. Expanding on the studies conducted by State, local, and industrial organizations, the Water Quality Network organized by the U.S. Public Health Service to monitor stream conditions is rapidly becoming a valuable source of information in determining whether stretches of streams are improving or regressing, and may also become a source of information for determining cause and effect relationships in stream quality. Concerning such cause and effect relationships, Daniel J. Enright (*5*), superintendent of water purification, Cincinnati, reporting on break-point chlorination experiences, states that "when the first of these six periods (of high break-point chlorination) struck (November 1951), we thought of industrial wastes. Others along the Ohio pursued the same thought We had then about 2¾ years of experience with the Ohio and its chlorine demand characteristics, and believed we knew something of them. Now, after 10 years, we are more cautious, but do believe that these peaks are due principally to normal degradation products of nature with streamflows governing the intensity and duration." Accurate, meaningful stream quality measurements have been and will continue to be essential to sound progress in stream quality improvement.

### (8) Municipal treatment of industrial wastes

There has been a growing sense of joint responsibility in the handling of industrial waste waters within municipalities. This was brought out in a study conducted by the Subcommittee on Combined Treatment of Industrial and Municipal Wastes of the Chemical Industry Advisory Committee of ORSANCO (*6*). Based upon replies to a questionnaire concerning handling of industrial wastes, the committee came to the following conclusions: "Although impossible of reduction to a table or number, there was evident in the tone of the overwhelming majority of replies, a spirit of cooperation between municipality and industry in solving the industrial waste treatment problem. This might be considered the most important conclusion of the survey. Most of the municipalities surveyed accepted industrial wastes either without reservation or with only general prohibitions against materials harmful to the system or its function. Only 11 percent of the respondents established fixed numerical limits on specific materials. Industry likewise was reported as generally willing to study and take care of real offenders. The two—municipality and industry—approached waste treatment as a common problem which they must both work to solve."

As both industries and municipalities are becoming more aware of their joint dependency, some unusual but altogether practical joint ventures are coming into being. A unique case is cited by Schrader (7) in which the city of South Charleston built a joint municipal-industrial waste water treatment plant, designed by Union Carbide Chemicals Co. and operated by a treatment company set up as a subsidiary of Union Carbide. This and many other, perhaps less unique, cases of successful municipal-industrial negotiations indicate a promising trend shaping the future.

## Summary

Where does industry stand in water pollution control? In evaluating the past, industry can stand on the record—a record that shows substantial progress.

The greatest promise of the future is the increasing recognition of the need to integrate industrial waste management with production, with waste research a partner of process development.

The exchange of information and coordination of effort made possible through the National Technical Task Committee on Industrial Wastes, has and will continue to stimulate effort in industrial wastes management. Since so much industrial wastes control involves inplant waste conservation measures, progress must necessarily come from within the industrial framework, stimulated by careful, realistic evaluations of stream quality and water uses developed by stream pollution control administrators.

Industry is responsive to the public interest as demonstrated by the accelerated progress in industrial wastes control during the past decade. The trends shaping the future indicate that responsible industrial management will continue to recognize the part it must play in stream quality improvement.

## References

1. Hoak, R. D., "Significance of Industrial Wastes." Reprint from Transactions of 19th Annual Meeting of Industrial Hygiene Foundation, Pittsburgh, Pa., November 17–18, 1954.
2. Streeter, H. W., "Natural Stream Purification as Applied to Practical Measures of Stream Pollution Control." Sewage Works Journal, *10*, 4, 747 (July 1938).
3. Hammond, R. J., "Benefit-Cost Analysis and Water Pollution Control." Food Research Inst., Stanford University, Miscellaneous Publication 13 (1960).
4. Boruff, C. S., "Byproduct Recovery, Pollution Control Measure in the Fermentation Industry." Chem. Engineering Prog., *55*, 11, 82 (November 1959).
5. Enright, D. J., "Operating Experience with Activated Carbon and Chlorine for Taste and Odor Control." Taste and Odor Control Journal (Published by Ind. Chem. Sales Division, West Virginia Pulp & Paper Co., 230 Park Avenue, New York 17, N.Y.) *25*, 10, 1 (October 1959).
6. Subcommittee on Combined Treatment of Municipal and Industrial Wastes of the Chem., Ind. Adv. Comm. of ORSANCO, "Current Practices in Municipal Treatment of Industrial Wastes." Sewage and Industrial Wastes, *29*, 6, 672 (June 1957).
7. Schrader, G. P., "Joint Industry and City Waste Treatment: Combined Approach as Viewed by Industry." Journal W.P.C.F., *32*, 2, 157 (February 1960).

FIGURE 1

QUESTIONNAIRE USED IN SURVEY

YOUR ESTIMATE OF THE POLLUTION CONTROL SITUATION

State ____________________

1. What is your estimate of the number of municipalities and industries that—

| | *(a) Were providing treatment in 1950?* | *(b) Are providing treatment now?* |
|---|---|---|
| Municipalities | (Col. 1) | (Col. 3) |
| Industries | (Col. 6) | (Col. 8) |

2. What is your estimate of the number of municipalities and industries that—

| | *(a) Needed treatment in 1950?* | *(b) Need treatment now?* |
|---|---|---|
| Municipalities | (Col. 2) | (Col. 4) |
| Industries | (Col. 7) | (Col. 9) |

3. What is your estimate of the number of municipalities and industries currently in need of additions or improvements to existing facilities?

| | |
|---|---|
| Municipalities | (Col. 5) |
| Industries | (Col. 10) |

TABLE I.—*The pollution control situation as estimated by State agencies*

| State | Municipalities | | | | | Industries | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1950 | | 1960 | | | 1950 | | 1960 | | |
| | Treatment | | Treatment | | Improvements needed | Treatment | | Treatment | | Improvements needed |
| | In operation (1) | Needed (2) | In operation (3) | Needed (4) | (5) | In operation (6) | Needed (7) | In operation (8) | Needed (9) | (10) |
| Alabama | 135 | | 168 | 38 | 26 | 37 | | 97 | 25 | 23 |
| *Arkansas | 107 | 30 | 114 | 15 | 80 | 54 | 200 | 156 | 85 | 15 |
| California | 340 | 134 | [1] 578 | [1] 32 | | | | [1] 1,420 | | |
| *Colorado | 93 | 138 | 162 | 188 | 69 | 18 | 30 | 20 | 40 | 25 |
| *Connecticut | 53 | 90 | 81 | 32 | 17 | 105 | 310 | 160 | 200 | 20 |
| *Delaware | 35 | 51 | 45 | 51 | 5 | 5 | 350 | 342 | 383 | 18 |
| *Florida | 36 | 134 | 456 | 50 | 40 | 30 | 30 | 150 | 200 | 100 |
| *Illinois | 299 | 125 | 383 | 199 | 59 | 92 | 150 | 230 | 75 | 50 |
| *Indiana | 85 | 150 | 144 | 125 | 27 | 250 | 50 | 321 | 16 | 54 |
| Iowa | 281 | 77 | 349 | 63 | 104 | [3] 197 | [3] 403 | [3] 274 | [3] 225 | [3] 70 |
| *Kansas | 182 | 88 | 330 | 5 | 35 | 5 | 75 | 41 | 30 | 15 |
| *Kentucky | 73 | 61 | 105 | 34 | 32 | 85 | 125 | 176 | 40 | 35 |
| Louisiana | 59 | 36 | 127 | 25 | 30 | [3] 50 | [3] 100 | [3] 75 | [3] 100 | [3] 25 |
| Maine | 11 | 40 | 21 | 35 | 45 | | | 12 | 25 | 20 |
| *Massachusetts | 62 | 83 | 117 | 33 | 20 | 49 | 200 | 79 | 181 | 22 |
| *Michigan | 154 | 128 | 262 | 25 | 71 | 199 | 139 | 392 | 15 | 56 |
| *Minnesota | 220 | 110 | 309 | 73 | 115 | 110 | 50 | 298 | 45 | 57 |
| *Mississippi | 7 | 175 | 64 | 87 | 100 | 0 | 40 | 4 | 36 | 40 |
| Missouri | 150 | 100 | 350 | 25 | 50 | (4) | (4) | (4) | (4) | (4) |
| *Nebraska | 118 | 324 | 203 | 239 | 260 | 1 | 10 | 4 | 8 | 5 |
| *New Hampshire | 8 | 61 | 13 | 56 | 4 | 3 | 30 | 12 | 21 | 11 |
| New Jersey | 410 | 50 | 468 | 15 | 50 | 70 | | 74 | 10 | 5 |
| New York | [5] 298 | | 448 | 139 | 51 | | | | | |
| *North Carolina | 275 | 164 | 379 | 88 | 60 | 10 | 90 | 32 | 50 | 15 |
| *North Dakota | 88 | 19 | 157 | 16 | 43 | 12 | 12 | 18 | 13 | 20 |
| *Oklahoma | 185 | [6] 27 | 269 | [6] 12 | 75 | 102 | 21 | 168 | 10 | 35 |
| Oregon | 97 | 96 | 181 | 62 | 33 | 27 | 88 | [2] 358 | 68 | |
| *Pennsylvania | 225 | 480 | 500 | 350 | 175 | 930 | 830 | 1,260 | 560 | 100 |
| Rhode Island | 15 | 2 | 19 | 0 | 3 | 3 | [3] 418 | 11 | 60 | 60 |
| *South Carolina | 153 | 54 | 172 | 35 | 43 | 33 | 114 | 79 | 74 | 26 |
| *South Dakota | 98 | 80 | 146 | 32 | 31 | 3 | 5 | 10 | 2 | 2 |
| *Tennessee | 67 | 46 | 108 | 30 | 37 | 70 | 112 | 186 | 70 | 95 |
| Texas | 669 | 25 | 700 | 4 | 157 | | | | | |
| Utah | 1 | 83 | 42 | [7] 57 | | 3 | 100 | 10 | [7] 100 | |
| *Virginia | 142 | 300 | 405 | 100 | 20 | 170 | 150 | 225 | 100 | 10 |
| *Washington | 83 | 177 | 230 | 62 | 37 | 175 | 525 | 1,018 | 109 | 109 |
| *West Virginia | 5 | 217 | 22 | 200 | 10 | 35 | 281 | 187 | 80 | 50 |
| *Wisconsin | 268 | 62 | 374 | 4 | 135 | 1,524 | 775 | 1,107 | 227 | 200 |
| Total (26 States) | 3,182 | 3,375 | 5,550 | 2,141 | 1,600 | 4,070 | 4,704 | 6,675 | 2,630 | 1,185 |

[1] These are 1958 data. The industrial data are based upon facilities provided since 1950.
[2] Includes industrial waste treated in municipal plants.
[3] Percent.
[4] No data available; water pollution law effective October 1958.
[5] 1952 data.
[6] Sewered towns with no treatment.
[7] These totals include "improvements needed."
*Included in column totals.

# PANEL IV

*Tuesday, December 13*

**Research and Training**

*Critical Needs for Research Resources, and Training*

**Chairman**
DR. GORDON M. FAIR
*Professor of Sanitary Engineering*
*Harvard University,*
*Cambridge, Mass.*

**Co-Chairman**
DR. CHARLES A. BISHOP
*Director, Chemical Process Development*
*U. S. Steel Corporation,*
*Pittsburgh, Pa.*

**Public Health Service**
**Resource Personnel**
B. B. BERGER
H. A. FABER

## Morning Session

**Dr. Charles A. Bishop, *Presiding***

I am glad to welcome you this morning to Panel IV of this Conference. Our first speaker will be Dr. Erman A. Pearson.

# Critical Research Needs—Environmental Aspects

DR. ERMAN A. PEARSON
***Associate Professor of Sanitary Engineering***
***University of California***

It might be well at the outset to ease the mind of the reader relative to the implications of the title of this paper. While one might infer that a detailed discussion of a large number of research problems will follow, this is not the case. Instead, the writer has chosen to examine the general role and stature of research in water pollution control and to consider only two specific but typical problem areas to illustrate the inadequacies of research effort in this field.

### General Considerations

Research, both basic and applied, is a fundamental building block in the structure of modern society, especially in this era of rapidly expanding technology. The importance of research in modern technological development is well recognized. In fact, Ewell (*1*) and others have correlated national research and development expenditures with the Gross National Product and have concluded that the economic return on research investment is in the order of 100 to 200 percent per year. Indeed, a very high rate of return compared with other investment opportunities. Moreover, these rates of return on research investment are comparable with those estimated by several large industrial concerns for their own research programs.

It may be well to define at the outset the meaning of the terms basic and applied research. The definitions, while not precise, have been widely accepted and are adequate for this discussion, as follows:

(*a*) Basic research is investigation or study solely for the purpose of knowing better or understanding the confusing phenomena of nature—the law or order that underlies them. (National Science Foundation defines basic research as that in which "the primary aim of the investigator is a fuller knowledge or understanding of the subject under study, rather than a practical application thereof.")

(*b*) Applied research is that investigation or study directed toward specific problem solving or application of the findings.

## Research Expenditures

National research effort: What is the magnitude of the total national research effort, what fraction of that effort is allocated to basic research, and under whose sponsorship? These appear to be key questions. Table 1 reports the annual national expenditures for research, the fraction of the total represented by basic research and its sponsorship, for the years 1953, 1958, and 1960 as reported by the National Science Foundation. It is noted that the total research effort increased from $6 billion in 1953 to $12 billion in 1960—a 100 percent increase in 7 years. The increase in basic research was even greater, from $432 million in 1953 to $1 billion in 1960. Today, basic research constitutes about 8 percent of the total research effort. Also, it appears that Federal sponsorship of basic research is increasing with industrial sponsorship decreasing.

TABLE 1.—*National research expenditures*

| Category | Year | | |
|---|---|---|---|
| | 1953 | 1958 | 1960 |
| Total research expenditures | $6,500,000,000 | $7,000,000,000 | $12,000,000,000 |
| Basic research expenditures | $432,000,000 | $835,000,000 | $1,000,000,000 |
| Industrial sponsorship ...percent | 34 | 30 | (?) |
| Federal sponsorship ...do | 45 | 51 | (?) |

Source: National Science Foundation.

Table 2 summarizes the relative proportion of industrial sponsored research expressed in percent of gross sales for representative years in the fifties. Data are given for all industry as well as for two specific areas, the chemical process industries and the extractive and mining industries. For industry generally there has been an increasing trend in research expenditures with an estimated 2.0 to 3.0 percent for research to sales in 1960. While there has been a slight decreasing trend in research to sales in the chemical process industries, it remains about 2.0 percent. However, there has been a marked trend in increased research expenditures in the extractive and mining industries, a national resource.

Water pollution: Where does the water-pollution control industry stand with respect to research effort compared to other areas of technology? Some criticism may be leveled at comparisons between a nonprofit industry concerned with the overall public welfare and segments of society dominated by the profit motive; nevertheless, there is justification for such a comparison. First, all segments of the water pollution control industry, except those in regulatory agencies, are responsive directly to profit stimuli. Second, the justification of expenditures in this area must be on the basis of common good and will rarely if ever yield a profit. Third, the total cost is paid ultimately by the taxpayer; consequently, the public as a group should be more concerned about the magnitude of a nonprofit expenditure than that of a profitmaking investment.

TABLE 2.—*Magnitude of industrial research*

| Industry classification | Total research (R. & D.) expenditures—percent of gross sales | | | |
|---|---|---|---|---|
| | 1951 | 1955 | 1958 | 1960 |
| All Industry | 1.3 | 2.8 | 2.0 | [1] 2.0–3.0 |
| Chemical process | 2.9 | 2.5 | 2.1 | (2) |
| Extractive and mining | .9 | 1.5 | 3.0 | (2) |

[1] Estimate.
[2] Data not available.

Source: National Science Foundation.

It is necessary to define arbitrarily the character of the water pollution industry to develop realistic estimates of its relative research effort. Certainly this industry encompasses some fraction of the water-supply-treatment activity as well as the waste treatment field because of the influence water-supply considerations have on water-pollution control expenditures. Conceivably, there would be minimal water-treatment requirements if there was no water pollution. However, for purposes of this paper and in the interest of conservatism, consideration will be given to that industry concerned only with waste treatment or direct water-pollution control.

Since it is common in industry to compare relative research emphasis on the basis of the ratio of research to sales, the question exists for the water-pollution control industry, what constitutes gross sales? One index of the magnitude of sales might be annual waste treatment construction expenditures since this parameter represents a composite of direct "sales" for water pollution control.

Table 3 presents a summary of sewage treatment facility construction costs for biennial intervals since 1950 as reported in the PHS Sewage and Water Works Construction Summary Report (*2*). It should be pointed out that these data do not include industrial waste treatment expenditures which would add significantly to the figures shown. Also included in Table 3 are liberal estimates of total national research and development expenditures and the ratio in percent of research to sales for each year. Of particular interest is the very low ratio of research to sales ranging from a minimum of 0.07 percent, in 1956 to the present level of 0.6 percent. The tenfold increase in the ratio of research to sales occurred during a period with a fourfold increase in sewage treatment expenditures; $137 million in 1952 to $500 million in 1960. The thirtyfold increase in research expenditures was based on a minimum of $100,000 in 1952 to about $3 million in 1960. However, if this industry was to just meet the national average in research to sales (~2.0 percent) it would require tripling the $3 million plus research budget for 1960 to a total of about $10 million.

To those familiar with current water-pollution control research efforts this would constitute a gigantic undertaking both with respect to available physical facilities and competent manpower. However, such expansion in research effort would meet only the present day requirements and would in no way suffice for future needs. It has been reported by McCallum (*4*) and others (*5*) that a minimum annual expenditure of about $500 million a year is needed just to maintain present levels of B.O.D. discharge with respect to the increase in population which is expected to reach 230 million in 1985. This does not consider the impact of new and exotic water pollution problems, including increasing radiation levels induced by expanding community and industrial complexes.

TABLE 3.—*Sewage treatment plant construction costs and estimated research expenditures*

| Category | Year | | | | |
|---|---|---|---|---|---|
| | 1952 | 1954 | 1956 | 1958 | 1960 |
| Treatment plant construction cost | $137, 000, 000 | $229, 000, 000 | $354, 000, 000 | $389, 000, 000 | ~$500, 000, 000 |
| Water pollution research | $100, 000 | $500, 000 | $1, 500, 000 | $2, 000, 000 | $3, 000, 000 |
| Research to sales ------- percent | 0. 07 | 0. 2 | 0. 4 | 0. 5 | 0. 6 |

Source material: PHS "Sewage and Water Works Construction Summary Report 1959" (2) PHS "Water Supply and Pollution Control Research Inventory 1958" (3) and personal data on research programs.

As much as one might want to avoid the thought and consequences, there is little doubt but that the most critical research need is development of financial support for a greatly expanded research effort. Expanded financial support would permit development of adequate research facilities and the education of competent engineers, scientists, and engineer-scientists for careers in research and development. Certainly the current health research facilities development program is a step, but a very modest one, in the right direction.

### Research Concepts

Several aspects of the total research problem, including the attitude of the practitioner (in the broadest sense) toward research activity and the selection of research problems, warrant special consideration.

Research and the practitioner: One of the appalling conditions currently extant is the generally negative attitude of practitioners at almost all levels toward water pollution research. This attitude appears to have a wide variety of origins, some of which can be described as follows:

1. The waste discharger is against applied research because the findings may provide a basis for more stringent control of waste discharge.
2. The regulatory official opposes research in areas where the findings might provide a basis for relaxing popular or established waste discharge controls. However, it should be noted that this group generally endorses research in areas where dramatic but practically remote hazards or risks might be found.
3. The designer may consider research unnecessary for at least two reasons:
    - (*a*) It is often said that even unique problems are similar to ones that have been solved previously and hence only minor adjustments in design are needed to solve the problem at hand.
    - (*b*) Research or investigative work has at best a low profit margin; and moreover, such work may result in a smaller plant and/or fee.
4. The general public is frequently opposed to research on an economy basis—research costs money.
5. Sometimes the attitude of dischargers, regulators, designers, and the general public against research may be the result of fruitless experiences where applied research or development had been supported without significant benefits or results.

Having cited some apparent motivation for negative attitudes toward research, it is only proper to cite some motivations for positive attitudes. A list of such motivations follows:

1. Recognition by representatives of all groups of the need for—
    - (*a*) Protection of the Nation's water resources.

(*b*) Scientific bases for selection of the kind of treatment required as well as specific process design criteria for treatment facilities.

(*c*) Economy and increased benefit in the problem solution that may result from well-directed and well-executed research effort.

2. The attitude of the "educator-promoter" who envisions the increasing emphasis on research as an opportunity to create a large "research empire" with less concern for quality of research than for the magnitude of research budget.

While the above comments may appear cynical, since the motivation for research by sincere, conscientious, and dedicated individuals from all areas has not been stressed, it is recognized that such persons do exist. However, in the writer's experience these individuals constitute a minority.

Additional evidence that research in this area has not kept pace with that of industry or in other areas of engineering was reflected in recent remarks of a former president and now chairman of the corporation of MIT. In the banquet address before a national meeting of the engineering society most closely associated with water pollution control, Dr. Killian stated, "More than any other branch of engineering, civil engineering needs to strengthen its foundations through research * * * especially * * * that kind of research which will generate the civil engineering of the future" (*6*).

Certainly greater interest in and support for research, both basic and applied, should be forthcoming from all levels of practitioners in the water pollution field.

Problem selection: As an educator facing continually the problem of selection of research areas or providing counsel to graduate students in such selection, the analytical basis for making selections warrants serious consideration. Practitioners, researchers, and educators active in the water pollution control field represent the following educational disciplines, approximately in order of their relative numbers in the field—

(*a*) civil engineers

(*b*) sanitary engineers (primarily civil) plus chemical and mechanical engineers with varying degrees of "educational retreading" in the biochemical-public health engineering areas

(*c*) chemists

(*d*) biologists (primarily bacteriologists)

(*e*) others

Individuals evaluating research performance tend to be critical of engineers and scientists working in an area other than that of their basic discipline. However, such multidisciplinary approach in research may not be optimum in efficiency but it is frequently necessary. This is because the paucity of scientific information in the water pollution field prevents a sophisticated engineering analysis and solution. Consequently workers in the field are forced to pinch-hit in disciplines other than their specialty, that is, occasionally engineers work in the role of a pseudoscientist if problems are to be solved. By the same reasoning, scientists often find themselves confronted with problems deeply involved in engineering. Nevertheless such an engineering-scientific dilemma should not affect the free choice of research problem areas.

To date the great majority of water pollution research is being conducted in or associated with engineering organizations, be it university, government, or private industry. Considering such relationship, one might expect criticism of the research leveled at its engineering or applied orientation. However, to some observers, including the writer, such criticism may not be necessarily valid. In fact, many engineering researchers with educational "retreading" in the basic sciences feel the urge to become "scientists" and believe that they can achieve this distinction by selecting research areas only on the basis of their interest or their curiosity. This, of course, is justified on the basis of "pure" or "basic" research and thus immune to critical appraisal or any kind of benefit analysis. Certainly a significant fraction of the research in the water pollution area should fall within the realm of basic research—but the question is, how much? The overall national research effort indicates that about 10 percent of the total research and development effort goes into basic research. Such a general division of effort in the water pollution field appears appropriate. Yet, there is a real danger in engineers attempting to conduct basic research. Because of the engineer's limited background in the sciences, he is not generally qualified for fundamental scientific research. While such research attempts may be educational and informative to the engineer-researcher, they are likely to yield relatively little benefit from the standpoint of basic science. The engineer-scientist should devote the major portion of his effort to application research because it is only he who appreciates the intricacies of engineering problem analysis and who shoulders the responsibility of coming forward with a working yet economic solution. Obviously a thorough background in the sciences should permit the development of more analytical engineering solutions.

It appears that the appropriate plea in this area would be for researchers to select problems in the specific area of their competence—for engineers and engineer-scientists to recognize their responsibilities as engineers and problem solvers—utilizing the scientific process to effect better solutions. Consequently, a minor but significant effort would be devoted to basic research. However, in all areas of research, the approach must be analytic, rational, adequate and specific to achieve the desired objectives. It is well to remember that the ideas for research work are almost infinite, but the capacity or financial ability to work on them is not. Consequently, considerable attention should be given not only to selection of the best research ideas, but also to the emphasis they should receive, as well as periodic reassessment of results and new research leads.

## Typical Problem Areas

The scope of research needs in the field of water pollution has been the subject of many papers and discussions. Thomas (*7*), on behalf of the Committee on Sanitary Engineering and Environment of the National Research Council, prepared in 1953 a list of research problem areas in waste treatment and disposal. Heukelekian and Wisely (*8*) published in 1954 the results of an extensive survey of workers in the field wherein a list of 87 research problems in need of solution was compiled. Similarly the National Technical Task Committee on Industrial Wastes (*9*) reported in 1956 a list of urgent research problems in need of study ranked in order of priority. McKee (*10*) summarized the above papers and included additional research suggestions in a paper presented at the 1958 conference on "Man Versus Environment." Recently Pearson, Pomeroy and McKee (*11*) prepared a summary-report on "Marine Waste Disposal Research in California" (1960) wherein a chapter was devoted to major research needs in the waste disposal area and 23 specific research areas were outlined.

It is believed that little could be added to the aforementioned "laundry lists" of research problem areas without going into a detailed technical discussion of each. Rather, two of the typical research areas will be examined to indicate the level of current research and practice in water pollution.

Health aspects: One of the areas of major technical as well as popular concern is the effect of water pollution upon man's health. Yet available scientific evidence does not permit a quantitative appraisal of the risk of infection from age-old enteric diseases that are associated with present bacteriological standards for drinking or bathing waters. There appears to be general agreement that the level of health risk associated with present acceptable levels of tracer (coliform) organisms is very, very low. Still the important point is that we don't know how low—even within orders of magnitude.

It is recognized that when the present bacteriological standards for drinking water were established, a rational attempt was made to consider the risk of infection and the probability of pathogen exposure. On this basis allowable tracer (coliform) organism concentrations were established. Also, there is little doubt but that the ratio of tracer organism concentration to pathogen concentration has changed markedly over the years, not only in the raw wastes but also in the environment—but how much? No one can give a specific answer for current conditions, and, of course, it is variable, but certainly such information should be available, at least to indicate order of magnitude changes.

Another example of the dilemma is the basis for selection of bacteriological standards for bathing waters. This is stated frankly in the California Health Department Report on a Pollution Survey of Santa Monica Bay (*12*), that the so-called "standard" of 10 E. coli (coliforms) per cc was set arbitrarily many years ago based upon California experience. Several supporting statements for the standard were cited, among which was the following:

> * * * any less severe standard as applied to disposal of raw or screened sewage in salt water would often show "approved areas" to lie within visible sleek fields of sewage and hance judgment would probably appear to a layman as lacking in commonsense and decency.

In spite of the bases or adequacy of the aforementioned standards in current practice, they are widely used and have become almost legendary. Hundreds of thousands of dollars are spent annually assessing compliance to these "standards." Yet, there have been only token efforts during the past decade to substantiate or evaluate the significance of these standards.

The common response to queries in this vein is that it is recognized that the standards are conservative—but who wants to drink or recreate in higher concentrations of sewage? That is another question, but first it is the engineer-scientists' responsibility to be able to estimate the relative risk associated with any sewage concentration of choice. The fact remains that we must live in an environment containing man's wastes—at least until the rocketeers can develop missiles to shoot waste off into outer space economically! But even then such practices may be subject to control.

Until data are available on the relative risk of enteric disease associated with defined exposure to known concentrations of tracer organisms (coliforms) and pathogen concentration, how can enlightened technical counsel be given regarding the safety of waters in countries where the ratio of tracer organism concentration to pathogens in the sewage is orders of magnitude lower than in the United States? Certainly our bacteriological standards based on tracer organism concentration cannot be transposed directly to situations in foreign countries.

The foregoing comments bear only on our know enteric disease and bacterial standards. Until we can cope with these problems effectively and rationally, what hope is there to be able to estimate risk or hazard associated with the known presence of viruses, toxic agents, carcinogens, and the like? Just the fact that they may be present is not particularly enlightening without information about the relative risk or hazard associated with defined exposure to such substances.

Perhaps radioactive contamination of waters is a good example in this respect. It is generally accepted that even the smallest increase in radiation exposure is harmful to man. But the question must be answered, how harmful, or what is the increase in hazard associated with a given increase in a specific kind of radiation? Such analytical methodology must be applied to all possible aspects of water pollution effects. Only research will provide the answers to such vital questions.

Considering the apparent apathy for scientific fact relating to waste discharge and man's health, compare this with a recent development in California. Because of sportsman and conservationist concern about the effect of sewage discharge upon the giant kelp, *Macrocystis pyrifera*, the California Legislature has appropriated more than $205,000 for research on the ecology of the organism as well as the effect of waste discharge. It is believed that this expenditure for research on waste discharge and kelp is substantially greater than the funding of any single research investigation on the effect of sewage discharge upon man's health.

Effects on the biota: Evaluation of the effect of waste discharge upon the flora and fauna of receiving waters has received even less attention than health effects. Again the popular impression and generally that of the regulatory agency is that waste discharge like sin is all bad, varying only in degree. It is the writer's conviction that fundamentally oriented, applied research on quantitative assessment of the physical, chemical and biological characteristics of receiving waters and sediments will show that properly controlled organic waste discharge can on occasion be very beneficial—even from the standpoint of productivity of the economic fishery.

However, let us examine the basis for assessment of possible adverse effects of waste discharge, especially as related to the discharge of known toxic materials. Conventional determination of the so-called "safe" concentration of toxic agent in the environment first entails determination by laboratory assays of the concentration of agent that will kill one-half of the test organisms (appropriate species of fish) in 48 hours. (48 hour TLm). Generally the so-called "safe" concentration is taken arbitrarily to be one-tenth the 48 hour TLm as recommended by the ORSANCO Aquatic Biology Advisory Committee (*13*). Recognizing the inherent limitations in estimating long-term "safe" concentrations from acute toxicity assays; nevertheless, the bland application of an arbitrary factor of one-tenth to the 48 Hr TLm is something less than scientific sophistication.

Since toxic response is a time-concentration phenomenon; that is, the response of an organism is a function of the concentration of agent and time of exposure, it should be possible to evaluate this function, albeit crudely, and thereby permit estimation of some lesser and "tolerable" degree of response for a specific organism, agent concentration, and duration of exposure.

Researchers in the University of California Sanitary Engineering Research Laboratory have been developing and evaluating live response type assay methodology with a variety of test animals, including fish, molluscs, annelids and crustaceans. Preliminary findings indicate that the concentration of an agent producing a 10 percent change in response (respiration or ventilation) rate in test organisms varies from a maximum of 5 times the so-called "safe" concentration $\frac{(\text{48-Hr TLm-Fish})}{10}$ to less than 2 ten-thousandths of the "safe" concentration, depending upon the agent and organism employed. Certainly the long-term significance of an induced 10 percent change in respiration rate of an organism can be debated. However, such gross variation in significant live response concentration levels as compared to those determined by mortality response should warrant much more research to determine the time-concentration-toxicity function for common and significant agents and organisms.

## Conclusions

It appears that the following conclusions can be drawn and should be implemented if orderly progress is to be made in the pollution control "industry":

1. A much greater research effort is needed to provide a scientific basis for technological progress in water pollution control. In fact, to establish research in this area on a basis comparable to all industry, a threefold increase in research effort and an annual national expenditure of about $10 million appears warranted.

2. If a $10 million research program is to be achieved, a corresponding increase in research facilities and competent personnel will be required.

3. A greater awareness of and appreciation for research is needed by the practitioners—dischargers, regulators, designers and educators alike, as well as the general public. This must go beyond "lip-service" and include support, financial and other, when appropriate.

4. Of the total research and development expenditures in water pollution, it would appear that an expenditure of about 10 percent of the total on so-called basic research is reasonable.

5. The critical nature of many of the complex water pollution problems provides an incentive for the engineer and scientist to conduct applied research in specific problem areas. For optimum progress in water pollution abatement, the researcher should consider both his competence in specific areas as well as the relative need for specific research within that area. The researcher should be very cautious in embarking upon research outside his specific area of competence.

6. A variety of source material is available providing detailed lists of critical research problems in the field of water pollution control. References to these source materials are included in the paper.

7. Of the numerous critical research needs, the following areas appear to be of major importance:

(*a*) Evaluation of the health hazard or risk associated with conventional tracer bacteria concentrations, as well as for concentrations of other contaminants including viruses, toxic agents, and radiation.

(*b*) Development of adequate methodology for quantitating physical, chemical, and biological effects of waste discharge upon receiving waters and sediments.

(*c*) Definition of the response-toxic agent concentration—time of exposure functions for common and significant organisms and agents to permit more realistic estimates of the so-called "safe concentrations" of wastes in the environment.

## References

1. Ewell, Raymond H. "Role of Research in Economic Growth". An address before the 43rd Annual Meeting of American Drug Manufacturers (April 14, 1955).
2. Green, R. S. and D. A. E. Beer. "Sewage and Water Works Construction 1959". U.S. Public Health Service Publication No. 758 (1960).
3. Butrico, F. A., H. A. Faber and K. Taylor. "Water Supply and Pollution Control Research Inventory 1958". U.S. Public Health Service Publication No. 768 (1960).
4. McCallum, Gordon E. "Water Pollution Control—A National Must". U.S. Public Health Service Newsletter (1956).
5. Ludwig, John H. "PHS Draws New Picture of Pollution Problems". Engineering News Record, pp. 29–30 (September 22, 1955).
6. Killian, James R. Speech before National Meeting. American Society of Civil Engineers, Boston, Mass. (October 1960)
7. Thomas, H. A. "Productive Research in Waste Treatment and Disposal". Sewage and Industrial Wastes *26*, p. 121 (1954).
8. Heukelekian, H. and W. H. Wisely. "Research Problems in Need of Study". Sewage and Industrial Wastes *26*, p. 1155 (1954)
9. Task Group. "Research Priority Selections". Proceedings Dec. 13–14, 1956 meeting of National Technical Task Committee on Industrial Wastes.
10. McKee, J. E. "Water Pollution—The Scope of Research Needs". Proceedings Conf. Man Versus Environment, pp. 31–48 (May 1958)
11. Pearson, E. A., Pomeroy R. D. and J. E. McKee. "Summary of Marine Waste Disposal Research Program in California". Publication No. 22, 77 pages, California State Water Pollution Control Board (1960).
12. "Report on a Pollution Survey of Santa Monica Bay Beaches in 1942". Bureau of Sanitary Engineering, California Dept. of Public Health (June 1943).
13. ORSANCO. "Aquatic Life Water Criteria". Sewage and Industrial Wastes *27*, p. 321 (1955).

# DISCUSSION

## Dr. Clair S. Boruff

***Technical Director, Hiram Walker & Sons, Inc.***

A word of encouragement might be offered to Professor Pearson and the rest of this group. The news of water pollution research is not all bad. In fact, many significant accomplishments have come from the pollution abatement research programs over the last few years, although the advances have not been well publicized. However, as Professor Pearson pointed out, the programs for pollution research do have some shortcomings. Considering the intent of this National Conference on Water Pollution, this seems to be the time and place to critically inspect these research programs and to suggest improvements.

Professor Pearson has compared the estimated annual expenditures for pollution abatement research with the expenditures for construction of municipal waste treatment plants. This type of ratio is often used in industry for assuring the propriety of research budgets. However, this ratio varies widely from industry to industry. For example, the expenditure for research and development in the aircraft industry is almost 18 percent of sales, while the average for all industries is about 3 percent. The chemical industry ratio is at about the average, 3 percent; the petroleum industry ratio is 0.75 percent; and the food industry, 0.25 percent. While these ratios illustrate current practices, certain further fundamentals determine research appropriations in industry. The final decisions on how much research should be done are based on need for the research and the ability to finance the research and its commercialization.

### Why More Research?

One of the questions before this conference is, "Do we need more research on pollution control?" I believe increased research effort is warranted, especially in the practical and applied research phases, and Professor Pearson has pointed out references and fields in which more and prompt research is needed.

As an industrial research man, interested for the past 35 years in water management problems, I should like to cite an area for which research attention seems imperative. I am concerned because of the staggering cost of waste treatment facilities of present standard design needed to reduce current pollution loads and loads of the foreseeable future. Research seeking more efficient treatment methods must be advanced to bring this cost down to a manageable level. Forecasts, based on present designs, estimate that more than $1 billion in construction will be required per year to completely meet municipal and industrial waste treatment needs.

### Financing of Government Water Pollution Research

To study the Government pollution control programs, it must be made clear, as Professor Pearson cited, that the $200 million in Federal grants over the past 4 years, which were matched with State funds to total over a billion dollars worth of construction, are construction grants. None of this money is available for research. Only $3 million per year in Federal matching funds has been appropriated for stimulation of State and interstate programs for engineering and research on pollution abatement.

An additional amount of somewhat over $1 million has been appropriated for research grants to universities for basic research in water pollution control.

The Federal facilities and scientists at Taft Center are assigned fundamental research problems of general national interest. Their appropriations are a part of the direct operating budget. The Taft Center men could serve as research coordinators to develop and coordinate the many State agency applied research programs, if such coordinating work were to be authorized and budgeted.

### Responsibility for Water Pollution Research

I believe firmly in the wisdom set forth in Public Law 660, whereby the prime responsibility for pollution is assigned to the polluting unit, be that an industry, municipality, or surburban subdivision; also, that the responsibility for applied research begins with these local units proximate to the pollution site. Pollution research of specific industrial interest should continue to be scheduled and accomplished by industry. The Federal program grants have successfully advanced pollution surveys and applied research by local and State government agencies, insofar as the grants have been available and insofar as the various programs have been coordinated.

### Need for Public Awareness of the Research Program

As Professor Pearson implied, research workers are quite normal. They, like everyone else, draw incentives not only from salary, but they also appreciate acknowledgment of their work and like to see the results of their research put to use. Here an improvement could be made in the management of pollution control research at no additional cost. Regardless of which agency accomplishes a research goal, the workers or their group agency should receive justifiable and complimentary publicity. Too often a significant waste research breakthrough, or even the abatement of a heavy pollution load, is judged as not as newsworthy as instances of needed pollution abatement.

### Examples of Current Water Pollution Research Accomplishment

Mention of a few current pollution research projects will illustrate what is being accomplished by the various agencies under the present appropriations and authority.

### Projects of Industrial Research Laboratories

Extensive industrial waste research programs are being conducted and financed by individual industries and by associations of cooperating industries. They do not draw on Government grants, but many of the programs would benefit from better coordination with Government-sponsored research.

The distilling industry, for example, is continuing to devise more efficient in-plant recovery methods. In another branch of the fermentation field, the antibiotic manufacturers have developed in-plant recovery and treatment methods for their potentially potent wastes. The soap industry has gone so far as to seek development of completely different detergent compounds to replace the present synthetic detergents, portions of which pass through conventional sewage treatment plants into the streams.

The Advisory Board's National Technical Task Committee on Industrial Wastes has screened and recommended research to extend the usefulness of waste stabilization ponds and activated sludge processes. As an example of how the above-mentioned correlating of research activity works, the Task Committee suggested that Government laboratories take care of accumulating the research data on these projects, also that interested industries be invited to operate treatment units of specified types. It was also suggested that program grants be sought so that a few qualified municipal treatment plants might gather applicable operating data.

### Projects of University Laboratories [1]

Two individual grants made under the university grants program may be cited for illustration of the type of research which is assigned to universities. A $13,800 grant has been issued to determine the "Role of Fecal Flora in Stream Pollution," and a $23,000 grant to investigate "Enteric Pathogens and Viruses in Irrigation Waters." Both of these projects further the knowledge on tracer organisms which Professor Pearson outlined.

### Projects at Federal Taft Center Laboratories [2]

The carbon filter technique for concentrating trace pollutants and its adaptation for stream monitoring was developed by Taft Center in cooperation with local and State agencies. By using this technique a chemical waste was found to persist all the way down the Mississippi from St. Louis to New Orleans. Discovery of this situation led to complete elimination of the discharge by the industry involved. The carbon filter monitoring network will also be used to assay the concentration in streams of the runoff of chemicals from farms. This is an example of one of the problems of "new wastes" which confront pollution control workers and which demand prompt research. In addition to manure and farm composts, attention must now be given to the stream damage sustained from the use of millions of tons per year of agricultural chemicals in the form of insecticides, herbicides, and fungicides. Substantial amounts of this tonnage wash to the streams, and not enough is known of the toxicity and persistence of the compounds.

---

[1] Public Health Service Research Grants in Water Pollution, Grants Awarded Fiscal Year 1960, List No. 2.

[2] Robert A. Taft Sanitary Engineering Center Technical Report No. W-59-3: "Research in Water Supply and Water Pollution at the Robert A. Taft Sanitary Engineering Center."

Extensive lists of unsolved pollution abatement problems which need prompt research attention were cited by Professor Pearson. These include such things as continuing investigations of the health hazards from viruses in streams and determining the permissible limits of the new exotic chemicals, which will involve toxicity and persistence studies, and the development of new microanalytical techniques.

The unsolved projects fall into three groups: first, those which are on the active schedules of the various Government research agencies; second, those which the agencies are holding as backlog projects, awaiting necessary funds and staff time; third, those projects which are in the developing and screening stages. In general, the active and backlog projects seem well screened. The development of new projects should continue with careful screening. As a suggestion, the research projects development and screening technique developed within the Industrial Wastes Task Committee might be more widely applied for project development by other agencies.

## Conclusions

1. Considering the extent of unsolved problems in water pollution technology, and considering the amount of waste treatment construction needed, Professor Pearson's conclusions warrant development and implementation.

2. Better coordination should be sought for the applied research conducted under the Federal program grants to local and State agencies. Similarly, coordination is needed to stimulate and to avoid unwarranted duplication of pollution control research programs conducted by industrial and agricultural research groups. Taft Center scientists are a qualified and logical group to accomplish this coordination. It is suggested that budget allowances be made to enable Taft Sanitary Engineering Center to accept this assignment as a further implementation of Section 5, Public Law 660.

3. Local and State units have proved efficient agencies for accomplishment of applied research and survey work. Therefore, the Federal program grants for this work should be substantially increased and extended to fully implement Section 5 of Public Law 660. The

present appropriation expires in 1961. This is an important State-Federal cooperative link. Needed research projects awaiting attention, which are suggested for this program include:

(*a*) Definition of the toxicity and persistence in streams of certain new chemicals;

(*b*) Determination of the dangers from widespread use of the newer agricultural chemicals;

(*c*) Development of more efficient waste treatment methods so as to reduce construction and operating costs.

4. The current research programs at Taft Sanitary Engineering Center and those projects which have been screened, evaluated, and planned for future program entry, appear well directed and efficiently conducted.

5. The current university grant projects in sanitary engineering, administered through the National Institutes of Health, appear of good potential value.

6. In your writer's opinion, it is a correct policy to assume that basic and applied research on specific industrial wastes is primarily the obligation of industry. Although many industries are commendably accomplishing abatement of their wastes, certain difficult or costly waste abatement problems should have prompt and positive attention.

7. A greater public awareness of waste abatement accomplishments as well as pollution control needs should be fostered. Complimentary publicity for water pollution research accomplishments is warranted.

Your writer acknowledges the aid of Mr. Russell Blaine, Sanitary Engineer, Research Department, Hiram Walker & Sons, Inc., in reviewing Professor Pearson's paper and preparing these comments.

# Critical Research Needs—Medical Aspects

DR. JOHN A. ZAPP, Jr.
***Haskell Laboratory for Toxicology and Industrial Medicine***
***E. I. du Pont de Nemours & Co.***

The fact that we are attending this conference on water pollution is evidence of concern about a number of aspects of our water supply—both present and future. We want not only an abundant and inexpensive water supply but above all a safe water supply from the point of view of human health. But questions have been raised about the safety of our present supply, and even more serious doubts about its safety in years to come. We are to discuss the means of resolving these questions and doubts insofar as research can do so.

In Abraham Lincoln's famous "House Divided" speech of June 16, 1858, he said: "If we could first know where we are, and whither we are tending, we could better judge what to do, and how to do it." Lincoln's words of 102 years ago apply to my problem this morning as they do to a great many other and unrelated problems. Before we know what research to recommend, we must first know where we are and whither we are tending.

We know, of course, that man cannot live without water any more than he can live without food or air. He must ingest a certain amount of water each day or perish. He need not necessarily take this water in its pure form since the body will accept it and use it even when diluted with other materials like tea, coffee, alcohol, milk solids, cola extract, etc., provided that these additives to water are not present in too high concentration. This is, perhaps, expressed in a French proverb to the effect that water is only for bathing, while wine is for drinking.

Man does not burn water for energy as he does food, nor does he change it chemically as he does the oxygen of the air. Man only borrows water for a short time since normally over the long run his daily input of water is equaled by his daily output. What does he do with this short-term loan?

The human organism has been aptly described as essentially an aqueous solution in which are spread out colloidal substances of vast complexity. The essential reactions of life, by which matter and energy are exchanged with the environment, take place in an aqueous medium. Food is brought from the gastrointestinal tract into the bloodstream in water. It is transported by the bloodstream to various parts of the body dissolved or suspended in water. And when the food is burned for energy or converted to flesh and blood for maintenance and repair, the unusable parts and waste products are transported in water to the channels of excretion.

Some of the water used in transporting waste materials to the channels of excretion can be "reclaimed" by the body with the result that the waste products are excreted in a more concentrated solution than that in which they were transported around the body. There is, however, a limit to the reclamation process and some water must be lost from the body each day and replaced by the ingestion of new water.

Water also serves man in an entirely different manner. As you know, the temperature of the healthy body is maintained rather precisely in both summer and winter. When it is necessary for the body to lose heat, the evaporation of abundant perspiration provides a great deal of the necessary cooling. When it is necessary for the body to retain heat, perspiration is greatly reduced. This thermoregulating function of water is related to its latent heat of evaporation rather than to its solvent power.

Man uses water, therefore, as a transport medium for getting things into and out of the body; as a reaction medium in which the chemical reactions of metabolism are carried out; and as a heat transfer agent.

As noted earlier, chemically pure water is not necessary for the performance of these functions. In fact water as pure as the distilled water used in automobile batteries not only tastes flat and uninteresting but is probably not as good for us as the water we draw from our taps, which contains small amounts of useful minerals.

How then do we define good water? A British source (*1*) defined it recently in the following terms:

> **As a chemically or physically pure water cannot occur in nature, purity implies pleasing to the senses, that is, absence of visible particles, turbidity, colour, taste and odour, and freedom from excessive amounts of substances in solution not normally detectable by the unaided senses. Potability, therefore, implies physical attractiveness as well as safety.**

The U.S. Public Health Service Standards of 1946 (*2*) says of potable water, "The turbidity shall not exceed 10 p.p.m., color 10 p.p.m., total solids 1,000 p.p.m., and odor and taste shall be absent." The USPHS standard sets mandatory maximum limits on lead, fluoride, arsenic, selenium, and hexavalent chromium; and recommends maximum limits on phenolic compounds, iron and manganese, copper, zinc, magnesium, chloride, and sulfate.

By both British and American standards, good drinking water is not pure water, but it is rather a very dilute solution attractive in appearance, pleasant in taste, and noninjurious.

Good water in the above sense is often found free in nature. Or putting it the other way around natural water as found in springs, wells, lakes and streams can be good water, and good or bad, natural water was until about a century ago man's only source of drinking water. It is probably still the source of drinking water for the majority of our population, since in 1940 only 38 percent of the population used treated water (*3*).

However, natural water can also be bad water so far as purity and wholesomeness is concerned. As it comes in contact with rock and soil, and living and dead organic matter, it picks up many substances. It may be turbid, colored, and have an unpleasant odor and taste. It may be safe to drink in spite of these properties, or it may be attractive in appearance and unsafe because of the chemicals it contains or because it may contain living organisms such as bacteria and parasites which are harmful to man.

Our greatest problem in the past has been with the biological contaminants of water rather than with the chemical contaminants. To be sure some natural waters were found to be unfit to drink because of their chemical composition, but these were in the minority and could usually be recognized because of the prompt and consistent ill effects which followed their ingestion.

It is difficult for us in this day, however, to appreciate what a mystery the infectious diseases posed just a century ago. Before the work of Pasteur, Lister, Koch, and others in the second half of the 19th century, the role of germs in causing disease was unrecognized. And, of course, the role of water as a carrier of germs was also unrecognized. Since germs are invisible to the eye and do not alter the taste or appearance of water and since they could be present in water at one time and not at another, it is easy to see how difficult it was for our ancesters to associate water with epidemics of disease. To be sure, the authorities of London in 1854 did suspect that cases of cholera were in some way associated with the use of a public pump and they closed it down with good results, but they didn't understand why or how the pump was at fault. In Old Testament times the Philistines reasoned that an epidemic of tumors was in some way associated with an infestation of mice, and they too were probably correct without understanding why (*4*).

By the 1870's the germ theory of disease was established, and only then could the role of water as a carrier of pathogenic organisms be understood and appreciated. The public health authorities of the late 19th and early 20th centuries were challenged to discover, through research, methods for rendering water bacteriologically safe. And they met the challenge with success. We need no longer fear major epidemics of such waterborne bacterial diseases as typhoid or paratyphoid fever, dysentery, and cholera—if we put into practice the knowledge available to us.

The principles involved in the modern supply of good drinking water are these: (1) keep the sources of such water as free as possible from contamination by chemicals and bacteria; and (2) treat the water supplies by such measures as sedimentation, filtration, aeration, chlorination, etc., before consumption, thus making assurance doubly sure.

This is where we are today. But this Conference bears witness to the fact that we are not satisfied with our position today and that we look with some concern to our present and future position. Why?

A part of our problem is associated with our rapidly growing population. Both man and the industries, including agriculture, which support him are pouring out ever-increasing amounts of waste products per square mile per day. Some of these are deliberately removed via water, as with sewage and some industrial wastes. Some migrate indirectly into water as they are washed out of the air by rain or leached from the soil. The total burden of waste disposal is bound to increase with increasing population, and water will share some of that burden. This means that we might anticipate an increase in the contaminant burden of the natural waters used as sources of public supplies. It is legitimate to ask whether present methods of treating such sources will continue to be adequate for the production of reasonably pure and certainly wholesome water. It has been noted, for example, that present treatment methods do not always remove traces of detergents from water.

Secondly, we are concerned about viral diseases because viruses may not be destroyed by present methods of water treatment, such as chlorination. We were concerned about the role of water in the transmission of poliomyelitis. We are concerned that it might have some role in the transmission of viral hepatitis or perhaps be implicated in viral diseases not yet recognized.

Thirdly, we must be alert to the role of certain bacterial and virus carriers in water. The U.S. Public Health Service has reported (*5*) that nematodes, tiny worms which are often found in water can pass through water treatment plants and survive chlorination. These nematodes might be carriers of harmful bacteria or viruses and could, in effect, smuggle them through the water purification plants.

Finally, we must give attention to the pollution of water with new chemicals. Our advancing technology has created a great many new compositions of matter, literally thousands of new compounds which have filled some need. Some of these or their waste products are discarded into sewers and effluents after they have served their purpose. Some, like radioactive fallout, are washed from the atmosphere by rain, or fall as particulates to the earth's surface. Some, like agricultural chemicals, may be washed from crops or leached from the soil by rainfall and irrigation. Some of these, in minute amounts, may find their way through the purification plants and into the water supply.

The synthetic detergents offer a case in point. After being used by the housewife to wash dishes, clothes, and the like, they go into the sewer or wherever else waste water is discarded. Certain of the most popular of these, the alkyl-benzene-sulfonate detergents, are not as easily destroyed as soap. Some of them get through the sewage treatment plants and water purification plants or seep through the soil into wells. If the final water contains about 0.75 p.p.m. or more of the detergent it will foam when shaken or drawn from the tap. The effect is startling and it has occurred in many areas. Is it harmful? Is the water unwholesome? This is the kind of question asked about all the new chemicals.

Note, however, that it is a different kind of question about wholesomeness than that which has been asked heretofore. We know that the ingestion of these waters produces no immediate harmful effects. But what of the long run? What about 20 or 30 years from now? Will the continued ingestion of these waters over the years lead to some cumulative effects which eventually produce disaster? The horizon of our concern has been pushed further into the future in these last decades.

Whither are we tending? We have an increasing population and an increasing amount of waterborne waste to dispose of. As we relax our concern about waterborne bacterial diseases, we begin to worry more about the viral diseases. As we create new chemicals and use them, we become concerned about the possible long-term effects of traces of these new chemicals in our water supply. And, of course, we will need increasing quantities of wholesome water to meet the needs of our growing population.

These, as I see it, are the problems that affect human health. Opinions differ as to whether they are serious problems today, but they are real problems and must be evaluated both for today and the future.

Of the total 240.5 billion gallons of water per day withdrawn by the United States in 1955, 3.6 percent went for domestic residential use and 96.4 percent went for other uses, industrial, municipal, and agricultural *(6)*. And practically all of this water is returned to the earth and its natural water reserves in one way or another. If contamination of waste water is to be a matter for concern, it would appear that uses other than domestic residential are the main concern.

In particular, the increasing trend toward atomic powerplants or nuclear processes in general poses a great problem of radioactive waste disposal. It has been calculated that all of the earth's waters would be unable to receive safely the bulk of the wastes of this industry (*6*).

Because of these problems, a recent article (7) stated: "That day is dead when it seemed only natural and logical for Americans to discharge raw industrial wastes to the most convenient stream." The Du Pont Co. alone has invested some $56 million to date on the control of air and water pollution from its plants, and I believe that we are representatives of industry rather than the exception.

Now I do not believe that absolute prohibiton of the discharge of wastes into natural waters is either necessary or desirable. Water, like air, should be used to serve man but it should be used intelligently. We have a problem with many of our streets and highways because useful traffic lanes are often blocked with parked cars. It is an old problem which antedates the automobile, for the old English common law contains the dictum that "the King's highway is not a common stable yard." In the same sense our rivers and streams are for use, but not as a common sewer.

It seems to me, therefore, that we need research on the limits to which water can be safely used for the disposal of waste. These limits will obviously be affected by our ability to reclaim contaminated water for reuse. The two go hand in hand. And I might add here, that we do know how to reclaim even highly contaminated water, such as sea water, but at a price which we do not want to pay today. Perhaps in the future we may have to reconcile ourselves to this kind of solution to the water problem. We can have good water if we pay the price. According to a recent report (*8*) there has been constructed for the Air Force's School of Aviation Medicine a 7-ton space simulator in which urine and all other waste waters are recovered and purified by chemical treatment, filtration, superheating, freezing, and final passage through activated carbon, with resulting drinking water of good quality. But for the time being we should seek, I believe, to restrict the contamination of raw water supplies to the point where reasonably inexpensive treatment can reclaim it for drinking and other usage.

One of the rather amazing and fantastic developments in the treatment of wastes has been the development of microbial systems which can be bred to destroy a wide variety of chemical wastes. Thus, by treating wastes with activated sludges before discharging them into public waters, important contaminants may often be removed. This procedure deserves and is receiving continued attention in research.

As for the role of water as a carrier for viral diseases, I can only say that this, too, is a critical research area. Progress is being made as the whole science of virology progresses, and I don't think that the problem of water will be overlooked.

So far as public reaction is concerned, I believe that the greatest concern is with the safety of water from the point of view of chronic toxicity. It is easy to show that one can drink a given water without any immediate observable ill effects, but one can always add the "Yes, but * * *." But what will happen if I keep on drinking this water day after day, year after year? Can I sustain some injury that will only be manifested two or three decades from now?

The question arises from the fact that the water we drink is not pure $H_2O$. As we have seen, it does contain trace amounts of dissolved chemicals, both inorganic and organic. Some of these are not only harmless but beneficial like chlorine residues of 0.1 or 0.2 p.p.m., or like fluoride ion at a concentration of about 1 p.p.m. But what about the rest?

In my opinion the toxicity problem of trace contaminants of water is exactly the same as that of trace contaminants of food which are subject to regulation under the Food, Drug, and Cosmetic Act as amended. Under that Act it is accepted that safe levels of contamination in food can be specified for all classes of chemicals except those found to induce cancer when ingested by man or animal. These latter, by law, are not to be permitted in food in any concentration other than zero.

On principle, if we can establish safe levels of ingestion for contaminants of food, we can establish them for contaminants of water—or of air, for that matter.

The reasoning back of the Food, Drug, and Cosmetic Act as amended is this. First, the science of experimental toxicology has demonstrated that for each toxic material there is a necessary and sufficient amount which must enter the body before the toxic effect appears. If this amount is small, we call the material "highly toxic"; if large, we call it "slightly toxic" or "practically nontoxic." But if the dose were large enough, we could kill with common table salt or baking soda.

Second, the toxic effect of a given material diminishes with decreasing dose and eventually disappears. In every experimental study of toxicity it has been possible to select doses so small that the characteristic toxic effect of the material does not appear within the normal lifespan of the test animals even when the material is administered over that entire lifespan. This includes even the chemical carcinogens.

Perhaps these concepts can be illustrated by analogy to the action of a common drug. If we have a simple headache, which we know from past experience is amenable to aspirin, we can expect relief by taking aspirin. Usually, one or two 5-grain tablets will suffice. Few people, however, would expect a tenth or a hundredth of an aspirin tablet to cure a headache, and if they did they would be disappointed.

In other words, the therapeutic effect of a drug diminishes and disappears with decreasing dose. As a matter of fact, aspirin has both therapeutic and toxic effects. About 150 5-grain tablets would kill the average man or woman and we count on the fact that this lethal effect has disappeared when we take one or two tablets for the therapeutic effect.

If it were not true that the human body can cope with sufficiently small doses of toxic chemicals, the human race would, of necessity, have perished long ago since almost all food and water as well as the air we breathe contain and have contained small amounts of materials which, in larger doses, would produce definite toxic effects.

The important question with respect to contaminants of food or water is whether they are present in the range of concentrations that the body can cope with or whether they are in the range which would produce even minimal cumulative toxic effects. And since I used them as an example I might add that the evidence suggests that the reported concentration of detergents in drinking water are in the safe range.

The safety problem with respect to food and water is then twofold: we must be able to recognize safe levels of contamination with respect to given materials; and we must then be able to control the contamination within the safe levels.

In the past, safe levels have sometimes evolved from the observation of effects or lack of effects on man himself. The maximum amount of quartz dust in the air that one can tolerate without developing silicosis was arrived at years ago by observing the actual concentrations in various industries and correlating the levels with the occurrence or nonoccurrence of silicosis among the workmen. The safe level for quartz dust established by this procedure has turned out to be satisfactory. But we are interested in the establishment of safe levels before rather than after anyone is injured.

The most satisfactory procedure for the evaluation of safe levels of chemicals in food or water is currently the long-term feeding test with animals. By feeding graded doses, we can establish the maximum level which produces no adverse effects. With some species, such as the rat, the lifespan of approximately 2 years is short enough so that it is practical to feed the test materials from infancy through old age. The 2-year rat-feeding study is consequently one of the most commonly used tests for evaluating no-effect levels of ingestion of food or water contaminants. It is reinforced by also feeding the same material to another, nonrodent, species such as the dog for 1 or 2 years. By a no-effect level of ingestion we mean that no effect is produced on growth rate, behavior, the length of the lifespan, or reproductive capacity; no detectable biochemical or hematological changes occur; and there are no gross or microscopic pathological changes evident after sacrifice of the animals.

We can, therefore, determine no-effect levels of ingestion for animals. But we must extrapolate these levels to man. It is generally agreed that we ought to provide some margin of safety in the extrapolation to allow for the fact that man may be inherently more susceptible than our test species. There is no exact scientific basis for attaching a numerical value to such a margin of safety, but the U.S. Food and Drug Administration has ruled (*9*):

> Except where evidence is submitted which justifies the use of a different safety factor, a safety factor in applying animal experimentation data to man of 100 to 1 will be used; that is, a food additive for use by man will not be granted a tolerance that will exceed one one-hundredth of the maximum amount demonstrated to be without harm to experimental animals.

It is believed by most toxicologists that the 100-to-1 margin of safety is more than ample.

Experience has shown that the 2-year feeding study approach plus a margin of safety does provide a sound and workable basis for establishing tolerances for chemicals in food. There have been no notable failures in using this method. It should work as well for water additives as for food additives, for the principles involved are identical.

The 2-year feeding study, however, is cumbersome, time consuming, and expensive. Certainly we need research which will lead us to more rapid and less expensive tests that would give the same assurance of safety. In view of the tremendous number of materials that might require evaluation as food and water additives or contaminants in our expanding technology, the need for these more rapid and less expensive methods is indeed, in my opinion, a critical research need. Physiological and biochemical approaches offer some hope of meeting the need, and work in the field is going on. Meanwhile, I believe that we can consider our present tools to be adequate despite their other drawbacks. If we are to continue to rely on them, however, we will need many more toxicologists and facilities, and some way of justifying the expenditure of large sums of money on the toxicity investigations of materials of minor economic importance.

We need, therefore, methods for establishing safe levels of ingestion of contaminants which are better in the sense of more rapid and less expensive; methods which are less demanding on manpower and facilities than our present ones.

When we have a valid estimate of a safe level of ingestion of a given contaminant, the next step is to control the concentration of that contaminant within the safe limit. This requires accurate and sensitive analytical methods, and much progress has been made in recent years toward their development. We may hope, however, that the limits of detection will be pushed even closer toward zero through advances in analytical techniques.

Knowing a safe limit, and being able to determine the material analytically with adequate sensitivity we still may have the problem of reducing the concentration of a given contaminant to its safe level by some form of water treatment. This problem is not insoluble, but the price tag may be too high for our present taste. Here again is an area of research needs—better inexpensive ways to purify water. I am not an expert in this field, but I note that no cationic coagulant aid is currently approved by the U.S. Public Health Service for the treatment of water supplies. I should think that cationic coagulant aids would be useful and should be developed.

To summarize our problem, we are going to have an increasing amount of waste to dispose of. We cannot recklessly discharge it into the nearest stream. The problem of water pollution begins with the discharge of wastes and the solution should begin there also. The available methods of controlling the discharge of contaminants into public waters are fairly good and are being applied but improvements are undoubtedly possible.

Secondly, there is every reason to expect that there will be some contamination of natural water no matter what measures we adopt. We must be alert to the possible role of water as a carrier of viral as well as of bacterial diseases.

Thirdly, we will have to evaluate the toxicity of those contaminants of water which evade our purification procedures. We have adequate but cumbersome and expensive procedures for this evaluation, but we badly need rapid and less expensive procedures of equal validity.

Finally, we must control the level of contaminants in water within the safe limits. This requires good analytical control as well as inexpensive and efficient purification procedures.

On the whole, I am inclined to feel optimistic about our problem. From the medical point of view there appears to be no necessity to eliminate all contaminants from water to insure its wholesomeness. We do require assurance with reasonable certainty that no harm will result from those contaminants which remain in water—or in food or air. We have recognized our problem; we know what we should do about it; and we are working on it. Our critical research needs are in the area of finding better, quicker, and less expensive procedures than are now available so that good quality water may remain a cheap and abundant commodity in spite of our increasing population and advancing technology.

## Bibliography

1. TAYLOR, E. W. and BURMAN, N. P., "Potable Water," J. Pharm. & Pharmacol. *8*, 817–831, 1956.
2. "Public Health Service Drinking Water Standards 1946," Public Health Reports *61*, 371–384, 1946.
3. WEIBEL, S. R., "Summary of Census Data on Water-Treatment Plants in the United States," Public Health Reports *57*, 1679–1694, 1942.
4. I. SAMUEL, 6.

5. Chang, S. L., Berg, G., Clarke, N. A., and Kabler, P. W., "Survival and Protection Against Chlorination of Human Enteric Pathogens in Free-Living Nematodes Isolated from Water Supplies," Am. J. Trop. Med. *9*, 136–142, 1960.
6. Cited in Hirshleifer, V., DeHaven, J. C., and Milliman, J. W., "Water Supply—Economics, Technology, and Policy," U. Chicago Press, 1960.
7. Ingram, M. W. and Towne, W. W., "Stream Life Below Industrial Outfalls," Public Health Reports *74*, 1059–1070, 1959.
8. Aviation Week, August 17, 1959, p. 59.
9. "Food Additives—Definitions and Procedural and Interpretative Regulations," Federal Register, March 28, 1959, pp. 2434–2440.

## DISCUSSION

Dr. Chauncey D. Leake
***Dean and Professor of Pharmâcology***
***College of Medicine, Ohio State University***

No matter how well we may be trying to control water pollution, as indicated in the detailed reports of Hirshleifer and his associates, and in the review by John A. Zapp, Jr., we continue to face real health hazards from contaminated lakes, rivers, harbors, and beaches. As our populations and industries grow, this health danger from polluted waters will grow also. Vigorous research is essential to control the situation. Much of this research may be health oriented.

Actually whatever will succeed in controlling or preventing water pollution will result in better health potential in the use of water, not only for drinking or household washing, but also for industrial purposes. No matter how we may get in contact with polluted water, we may thereby run a risk to our health. Even a look at some of our filthy harbor or river waters near a city can be disturbing to our mental health.

The current situation and the inevitable future in regard to water pollution calls for specific health aspects of the research indications for the control of water pollution: (1) continued awareness of, and vigilance regarding the varying extent of water pollution and effective ways for its control, on the part of governmental regulating agencies, industrial concerns, and community leaders; (2) long-range study of the best ways of controlling organic pollution, whether from excreta and garbage, with the ever-present danger of health hazards from microbiological organisms, from organic chemicals, or from oils; (3) continued investigation of safe limits of pollution with inorganic materials, with study or methods of estimation, long-range toxicity data, and effective methods of settling; (4) continued effort at the safe disposal of radioactive wastes; and (5) appropriate communication with the public, so that there may be public understanding of the need for continuing research on water pollution and its control.

From antiquity the tremendous buffering capacity of our airs and waters has successfully handled, without much danger to us, the appalling amount of pollution which we ourselves and our industries produce. Only recently are we becoming aware that the buffering ability of our airs and waters is reaching a limit. There are just too many of us, and too much pollution from our industries. Not only is this constituting a severe danger to our long-range health, but it is also slowly destroying all those esthetic values of the natural loveliness of waterways that should remain a source of joy and inspiration to the teeming millions that crowd our cities.

The important volume on "Water Supply: Economics, Technology and Policy," written by Hirshleifer and his associates and published this year by the University of Chicago Press, deserves wide attention and extended local comment and discussion. Similarly, the review by Dr. John A. Zapp, Jr., on the medical aspects of critical research needs on water pollution should get wide public interest. These important contributions must be followed up. We must increasingly be vigilant to the dangers which have been pointed out, and to the possible dangers that may come along as more water pollution occurs.

Perhaps the greatest danger to our health in regard to water pollution is in connection with organic contamination. Mainly this comes from the possibility of infectious disorders occasioned by worms, bacteria, or viruses, which get into water and which can grow there, as a result of pollution with animal or human excreta, and with garbage of all sorts. While we have found that sunlight and aeration can reduce the growth of most pathogenic microorganisms in running water or in ocean water, this may be a dangerous assumption. We have increasing evidence of balancing forces in ecology, but the pathogens remain. We need to get the facts.

We need to know also the extent to which our methods of purifying water for drinking purposes do actually remove danger from infectious organisms. Viruses may give us the most difficulty. Are the methods that we use for examination of drinking water, with respect to the potability and safety, adequate in the face of ever-increasing contamination?

Actually we haven't progressed very far in principle from the methods of water purification used by the old Romans, and as described so well by the water-commissioner, Frontinus, who served under Augustus. The drinking water in the fountains of ancient Rome was aerated in the aqueducts, and passed every 100 yards through filter chambers containing sand, which were regularly cleaned and filled with fresh sand. More importantly, the sources of the water for drinking were carefully protected against contamination by animals or humans. Perhaps we must reexamine some of the principles suggested by Frontinus. Certainly our technology would suggest ways of improving on them.

Characteristic of our heavy industrial development has been the increasing pollution of our waters with organic chemicals. Of particular interest are the household detergents. We simply don't know what overall effect these kinds of compounds may have on the safety of water, either for drinking, for household uses, or for industry. Usually organic chemicals are destroyed by buffering effects in water, and usually they may be coagulated out of water by appropriate treatment with cations or by other methods. However, we require continual vigilance in studying thoroughly all the new kinds of organic chemicals that are dumped into our waterways, and in devising ways of destroying or removing them.

Most disturbing is contamination of water by oils. This is commonplace outside our great harbors. It constitutes a fire hazard, a health menace, and an esthetic nuisance. In the tremendous expanse of our oceans, oilslicks are considered of negligible significance. Nevertheless, the oils continue to accumulate. In our fresh waters, the oils may cause all kinds of difficulties in purification, and they may in themselves cause serious disturbance in the general natural ecological balance toward which our waters tend. The oils destroy microorganisms, plants, fish, birds, and animals. The result can be a most serious health hazard.

Inorganic pollution is potentially the most hazardous long-range type of pollution, with respect to health, since the salts of the heavy metals are not readily destroyed. It is true that they may be precipitated out. Many, however, remain for a long while in solution, and unless specific precipitating treatment is used, they may constitute an accumulating menace.

Fortunately, the degree of inorganic pollution can be accurately estimated, and control measures can be instituted whenever the content of inorganic pollution exceeds agreed-upon limits. The U.S. Public Health Service limits for inorganic pollution were established in 1946. Perhaps they need restudy. Perhaps they need revision and extension, particularly from the standpoint of pollution with compounds of some of the rarer elements which are beginning to be used industrially.

Of paramount importance in water pollution are compounds of lead. Although present in water in very small traces, lead may gradually accumulate in our bodies if we drink such water. The ubiquity of lead in our industries, and as a result, in our environment, always should suggest to an alert physician that there may be a possibility of chronic lead poisoning whenever a diagnosis is difficult to establish in an obscure ailment.

It would seem that it would be wise for us to make every possible effort to remove all traces of heavy metal compounds from our potable waters. Indeed we should do everything we can to prevent the pollution of our waters with compounds of this type. Copper salts may rapidly destroy the ecological balance of ponds and waterways, and compounds of mercury, lead, arsenic and selenium may do likewise.

By far the most serious potential danger to our long-range health as far as water polution is concerned is in regard to radioactive wastes. The disposal of radiation wastes by sealing in concrete containers and dumping far out to sea may seem safe enough. However, we don't know the details as to how rapidly concrete may go to pieces in seawater, nor do we know the extent to which radiation may be distributed as a result of water currents. "Out of sight, out of mind," is not a very satisfactory way with which to handle this problem. We need to get just as much information as we can regarding the potential dangers from radioactive waste materials which may be dumped into our waters.

Fortunately, most of the research problems involving health aspects of water are capable of systematic chemical or biological investigation. The long-range potential toxicity of various pollutants can be studied even in minimum concentrations on small animals such as mice. With appropriate safety factors, the results can reasonably be extrapolated to humans. Data of this sort may be used to establish permissible limits of pollution. Nevertheless, the data should be reexamined from time to time and the limits reevaluated, as experience and information accumulates.

In this whole matter it will be wise for scientists, government agencies, and industries to take the public into their confidence—to make their findings known, and to enlist the informed support of people generally in protecting what is essential for us all. There is a tremendous stake in our water supplies, not only with regard to the health of us all, but also in the ever-growing industrialization upon which our standard of living depends.

## Panel IV

### General Discussion

**Dr. BISHOP.** We have with us today two gentlemen from the Public Health Service whom I have asked to relay your questions to the speakers. First, I would like to call on Mr. Harry Faber, of the Public Health Service.

**Mr. FABER.** There are two questions that are rather similar, and I think we might as well ask them both of Dr. Pearson. Dr. Gus Condo, of the Izaak Walton League of America, has this question to ask of Dr. Pearson: ***"Your analysis showing desirability of tripling research is good, but this proposal seems to be oriented entirely toward seeing how much waste can be discharged without affecting receiving waters. This approach is causing much criticism that existing discharges are selfishly using all the dilution capacity now. Why wouldn't a proportionate 'inplant' research effort to reduce waste loads and water use pay bigger dividends to industry?"***

The second question is from Dr. Richard D. Hoak, Mellon Institute: ***"To obtain the fullest beneficial use of streams, effective regulatory bodies have adopted the practice that discharge into a stream should be governed by the full assimilative capacity as measured at the point of use. What is your thinking on this?"***

Both of these questions relate to the assimilative capacity of streams and the discharge load being reduced by in-plant treatment of waste.

**Dr. PEARSON.** First, relative to the first question and the magnitude of the estimated research needs, I would like to state that these estimates are not based on the assumption of making full assimilative use of the receiving waters. That is a separate policy question.

The figures that I came up with were based upon what might be prudent for research expenditures in an industry, the water pollution control industry, comparable to those that have been pretty well established and recognized by profitmaking industry. This, of course, indicates nothing about the need for research in this field.

I might comment further. I don't think that the water pollution control industry is as advanced as any of the profitmaking industries relative to a scientific or technical base for operations. My plea was, then, that there obviously is a need proportionately greater than for industry generally; correspondingly, the least that should be done would be to spend a comparable amount.

Now, it is presumed that some of this research would define effects of waste discharge, good, bad, or indifferent, but how can we realistically deal with waste discharge unless we know what the effects are? Obviously, one of the hopeful benefits of the research would be to define these effects with far greater accuracy and precision than we have been able to do to date.

With respect to in-plant industrial research effort, the figures that I have used have been based upon only construction costs of municipal treatment plants. The research expenditures cited are not just, as may have been inferred by some, governmental research expenditures to date, but also include what I term "published industry research" expenditures. This means money that industry has put forward even by outside sponsorship to research institutions or research expenditures that they identify as a water pollution effort and have so included in their correspondence with the National Technical Task Committee on water pollution research.

Obviously, my figures do not include a whole host of industry "bottling-up" type research or in-plant waste conservation investigations that I am sure goes on and probably should go on, even at a greater rate than in the past. I think industry recognizes, or at least they should, that when it comes to reducing waste discharge, probably the most prudent expenditures are going to be made inside the establishment rather than in construction of a monument alongside the receiving waters.

Now, getting to the question of assimilative capacity of the receiving waters and whether or not regulatory action should be based upon full assimilative capacity. Personally, I think this should not be the case. Recognition should be made of the full assimilative capacity in the analysis of effects of any potential waste discharge but provision for unknowns and future development should allow assimilative capacity in reserve. Nevertheless, we must recognize, whether we like it or not, that the streams just like our atmosphere must be used as the ultimate assimilating mechanism for wastes in our environment. What we must do is to insure that conditions developed by this assimilation are favorable or at least tolerable and in the best interest of the general public.

**Dr. BISHOP.** Mr. Berger, of the Public Health Service, will ask the next question.

**Mr. BERGER.** This question is for Dr. Zapp, and was asked by Patrick R. Dugan, Syracuse University Research Corp.: ***"You have drawn an analogy between trace contamination in water and food. Under the existing food laws, the burden of proof of safety is on industry. Would you suggest that municipalities, industries, et cetera, assume the burden of proving that any effluent is free from trace contaminants which could be considered toxic?***

***"Secondly, which would you suggest be the regulatory agency? Surveillance agency?"***

**Dr. ZAPP.** Going back to the food law, the Act of 1938 did not put the burden of proof of safety on industry, but rather put it on the Government. The amendment of 1958 to the food law and cosmetic law shifted the burden of proof from the Government to industry. Industry did not oppose this shift. I feel that industry is in a better position to determine the safety of its effluent than municipalities or government, and that it has a moral obligation to determine whether or not it is putting something into a public water or food which is unsafe. So I would agree, or at least say that I think that industry should assume this burden rather than the municipality.

As for which would be the regulatory agency, I think this is outside the scope of my talents. I prefer to leave that to someone else.

**Mr. BERGER.** The second question is from O. C. Thompson, Manufacturing Chemists' Association, and is addressed to Dr. Zapp and Dr. Leake: ***"It seems generally agreed that more publicity with respect to water pollution control is necessary. How do you think this publicity can be made effective without permitting this publicity to become exaggerated in the popular press to a dangerous degree?"***

**Dr. ZAPP.** I can only say I wish I knew the answer to this question. Last March I participated in the President's Conference on Occupational Safety and the only digest of my remarks that appeared in any press was a horribly distorted version, in my opinion. I was disappointed.

I tried to do then what I tried to do today, to get across what I think is a balanced point of view, and it seems that the public communications media are not particularly interested in this kind of approach. They seem to be interested only in something which has a sensational news value. And as long as this is the case, I don't think we are going to be able to communicate effectively with the public. I believe that what we really need is, as Dr. Leake said, some better tie-up with communications agencies, so that we can get the message we are trying to get across to the public and get it to them in its proportion and balance, not in relation to one or two sensational items that attract attention.

**Dr. LEAKE.** Yes. There have been several recent conferences on this matter and I think that the responsible mass media directors are alert to the necessity of getting away from sensational spot news reporting of scientific affairs.

Two of these Conferences, one held under the auspices of Carleton College in Minnesota, brought together the leading editors of the major newspapers and magazine chains of this country, together with responsible scientists. The whole point of these Conferences was to explore ways by which there could be better understanding of science.

It is the concept of science that is important also. Personally, I have been extremely interested in this matter for a long time. Recently, in connection with the efforts of the American Association for the Advancement of Science, we explored ways to get better public understanding of science and always directed for purposes that are agreeable. All of us believe that our scientific knowledge does give us the ways by which we can control ourselves and our environment for our individual and social welfare.

Another recent conference, held under the auspices of the National Science Foundation here in Washington, explored this matter further with representatives from all the major mass media.

Now, the net result here is suggestions along these lines. First, to encourage the scientific experts themselves to learn to write, and I submit that this morning we had two admirable examples of what can be done. These discussions were presented in such a way as to give information which would be of interest to the public. One of the major ways of doing this is by serializing. Instead of the spot news story, you serialize the story. The mass media are becoming interested in this attempt.

In the second place, we have to remember always something of our own psychology. We think that when we have discussed a problem as here, and come to some sort of reasonable agreement upon it, that is it, at least for our lifetime or our generation. That is a lot of nonsense. With the rapid growth of our public, you have to repeat the stories every 5 years or so, if you are going to be effective. Gradually, it gets into the picture in the schools and gradually, our youngsters come along and understand what it is about.

I think we need research on research. We have to make sure that, first, we keep our purposes clear and agreed upon, and, second, that we do our best to promote the sense of individual responsibility. This is essential in our democracy, and every once in a while we lose sight of it and have to be reminded.

In the third place, we have to obtain honest motivation, if we can. That follows from the others. These points apply, it seems to me, to all our major social problems which have resulted, in large part, from the headlong and headstrong application of scientific knowledge to profitmaking rather than to public welfare.

**Dr. BISHOP.** I am glad to have a chance to call on a fellow Kansan, Dr. G. M. Martin, from the State Health Department, who would like to make a statement.

**Dr. MARTIN.** I must apologize to the company for having to make a statement. One should be able to say anything he wants to say in the form of a neatly worded question.

I wanted to say how grateful I was to Dr. Zapp and Dr. Leake for making a bridge between the contamination of water with chemicals and such, and the similar contamination of food and milk. This gives opportunity to relate the research in and attitudes toward pollution of water, with the body of research in and attitudes toward the pollution of food and milk, or if you wish, the contamination of food and milk, a thing we have been working on since 1900 or thereabouts.

One can come up with some ideas that are somewhat different from those expressed by Dr. Zapp.

You are probably aware that the original pure food laws, as established by Dr. Harvey Wiley, contained the thesis that if a substance was noxious to human beings, it shouldn't be allowed in food at all unless it was absolutely necessary to the production process. This so-called *per se* doctrine has practically disappeared under a variety of onslaughts, and we are now proceeding on the theory that every noxious substance has some minimum limits of toxicity, and below these limits it is not toxic to human beings. This introduces the interesting question of whether control of the contamination of food—or water—is a scientific matter or a social one. It is perfectly possible, for example, for an industrial plant to determine scientifically that one of its pollutants was theoretically safe in the drinking water supply of a downstream community, in the concentrations which might be expected, and with the definition of safety prevailing at that particular time. It is nearly impossible, however, for that plant to determine what other industries are adding what other contaminants in what concentrations, and whether these contaminants add to or potentiate the toxicity of the first contaminant, and so forth. Social processes become necessary. Choices have to be made. The needs of the industry must be balanced against the moderate wish of the public to have wholly unpolluted water and not to have to take risks with any unpleasant substance. Controls have to be imposed. If Manufacturer A is to put this in the water, and Manufacturer B this, and Manufacturer C this, the detoxifying mechanisms of the body may be overwhelmed. It may be necessary to lower all three outputs of contaminant, or to strictly control two and let the third proceed as before. The choices, the balances, the controls, all call for administrative machinery, and the public, which bears the cost of the machinery, is entitled to ask what value it is getting for the expense. What is involved is, in effect, a conflict between physiological man and economic man and social man, and I don't think such conflicts can be resolved by scientific means whether they deal with food or water or anything else. They can only be resolved by unscientific social processes.

Even when science can be applied, scientific knowledge refuses to stand still. We have recently had a good illustration of this in something that followed the new legislation on artificial colors. The compound known as FDC Red No. 1 has been used more or less in its present form for a long time. In 1938, when the Food and Drug Act was amended, it was considered perfectly harmless and therefore a proper subject for certification of purity. It has been certified by the Food and Drug Administration, and therefore by implication considered harmless for 22 years, until 1960. Recently many colors have been getting a bad name, and doubts began to be entertained about this particular one. Long-term feeding studies were carried out, and behold, FDC Red No. 1 wasn't harmless at all but toxic to the point that its use must be discontinued! It seems reasonable to believe that many other substances which are harmless by the feeding tests and other gross studies of the present, will not be harmless in terms of the tissue cultures and other more delicate tests in the future.

Obviously there is need for a vast amount of research. As a physician, I, for one, would hope that this research will not be directed at the maximum amounts of toxic substances that the assimilative mechanisms—your bodies and mine—can withstand, but rather would attack the basic aspects of this matter, how these toxic substances produce harm, and how harmful substances can be eliminated from the human environment.

**Dr. BISHOP.** I will read a statement submitted by Raymond L. Jewett, Precision Chemical Pump Corp.:

> Interest growing out of my business affiliation impels me to assert what I believe is a need for research attention in an area generally ignored in our present discussion. This area is that of the very small water supply and waste systems. It has been estimated that the United States has 6 million individual water systems and probably more individual waste treatment systems. Despite the existence of such systems in these numbers, research on their treatment needs and techniques has been left largely to interested industries. It is my contention that this is not proper, that the millions of people who depend upon such supplies have a valid claim on a share of the research activities of the nonpartisan university and governmental agencies and that this Conference should specifically recognize the existence and validity of this claim.

**Mr. FABER.** The question has been asked of Dr. Pearson by A. J. Wiley, Sulphite Pulp Manufacturers' Research League, as follows: ***"Do you know of any research now underway to apply the new process being developed by the Office of Saline Water to waste treatment problems? We are thinking especially of the membrane processes such as electrodialysis."***

**Dr. PEARSON.** I know very little about research that is being done in this area.

I have read in the literature of at least two applications in industry of at least pilot scale use of electrodialysis for waste treatment. One is associated with the purification of spent solutions in the photographic industries, essentially the developing solutions, the restoration of them from contamination by film contact. How widescale this is in terms of application, I don't know. But at least, it has has been investigated.

The second was the possible use of electrodialysis systems for recovering acid and iron from spent pickling liquors in the iron industry. I know in the latter case, this has proved to be impractical and extremely complex, because of many of the physical problems associated with the properties of the ion-exchange membranes as well as with clogging of the membrane effects.

In order for electrodialysis to be practical, you have to have a pretty pure solution, and then you have both physical deterioration and biological clogging of the membrane. Electrodialysis has been applied, as most of you know, to reducing the salinity of brackish waters in many areas around the world. In California, the city of Coalinga is using an electrodialysis installation for full-scale municipal water supply.

In this instance when you compare the economy of electrodialysis with importing water by tank truck, of course it is economically feasible.

**Mr. FABER.** Since electrodialysis is of interest in connection with the research work at the Sanitary Engineering Center, Mr. Bernard Berger might wish to make a brief comment on this question.

**Mr. BERGER.** I hate to intrude this way. However, the question is a very intriguing one, and I would like to take a minute to tell you that we at the Sanitary Engineering Center are doing some work in this field.

About a year and a half ago Gordon McCallum in a keynote paper at the Purdue conference called attention to the need for waste treatment beyond conventional secondary treatment. A year ago we convened a group of consultant physical chemists, including Carroll Morris of Harvard, Prof. Victor La Mer of Columbia, and Lou Koenig of San Antonio. We asked them to give us a hand in identifying new methods of approach to this matter of advanced treatment of waste.

Separation of impurities by electrodialysis was one method reviewed. Others were absorption, freezing, hydration, and additional methods that were new to our staff. Work on this program is underway. It is based essentially on contract research.

I would like to say that physical chemists and research chemical engineers are showing considerable interest in this program. I think we will see contributions from them in the application of these techniques to advanced waste treatment.

**Mr. FABER.** One question addressed to Dr. Boruff is somewhat similar to the statement which was read concerning small municipal water supplies. The question is from Dr. Clair N. Sawyer, Metcalf & Eddy, Engineers, Boston, Mass.: ***"Would you care to comment on the problem of small industries with respect to ways and means of solving their own problems in line with your comments relative to the responsibilities of industry?"***

**Dr. BORUFF.** For the small company having industrial wastes problems, first, I would suggest the use of outside consultants, well versed in the field. Second, I would suggest use of your specific trade association in your industry; undoubtedly, it has a waste committee. Third, refer to and ask for suggestions from the Public Health Service.

**Mr. BERGER.** I have a question for Dr. Zapp, asked by Dr. Ryckman of Washington University: ***"Should unpleasant taste, odors and color in waters be considered as producing possible direct physiological, or even toxic effects to those drinking or using water?"***

**Dr. ZAPP.** I think we have to divide this question and answer into two parts. Unpleasant taste, odor and color may produce a water which is esthetically unpleasant, without being harmful. I think I said this in almost those words in my talk, and although we here are apt to reject such waters for drinking because of the esthetics, there are many parts of the world in which they are not rejected where people actually drink water that we would not drink unless we were dying of thirst. These waters are not necessarily toxic. If other people accept what we consider unpleasant color, odor and taste, it will not necessarily produce a toxic effect.

If, on the other hand, water is unpleasant esthetically, I think we may anticipate some physiological effects of the kind produced by many things that upset us, for example when we smell certain odors that are unpleasant to us, our stomachs get upset, and so forth, and we may even imagine or be led to develop some sort of psychosomatic type of disturbance.

Toxicity is not necessarily associated with taste, appearance or color. The unpleasant looking, tasting, and smelling water may be toxicologically safe, and the water which looks crystal clear and clean may be dangerous. You just have to make a disassociation between odor, appearance and taste, and actual toxicity.

May I have a couple of minutes to respond to a couple of things that Dr. Martin has said?

**Mr. BERGER.** Yes.

**Dr. ZAPP.** Dr. Wiley was instrumental in getting the first Pure Food and Drug Act passed. He was dealing at that time with a situation quite different than that which exists today. If you will go back and look at the record, he was protesting against lead chromate in curry powder and mustard powder, red lead in pepper, against opium in soothing syrups. These were the problems that he faced, and he was thinking, and quite rightly, I believe, in terms of the complete elimination of these materials from articles of food and from drugs. The 1938 act continued this same *per se* concept of toxicity with respect to foods. It was dropped in the 1958 act, not because of pressure on the part of industry to put across something which was less safe, but rather because the toxicologists all over the country, including those in Government, recognized that the *per se* concept could not be depended on, on scientific grounds; therefore it was agreed on all sides that it was proper for the Government agencies to accept tolerances where they could be set with safety.

There is a parallel between the methods we use to determine the safety of a food additive and the methods we use to determine the safety of a water contaminant, but there is a different problem in the food field. There are certain things that are added deliberately to foods. These are called intentional additives. They are very easy to control and, believe me, it is almost impossible for one to get approval from the Food and Drug Administration to put an intentional additive into an article of food today, unless it serves a useful function and is safe in the amount used.

The big problem with food additives, however, concerns the unintentional additives, materials that are not deliberately added to food, but get there by migration from things which come in contact with food.

Let me take as one example food packaging. We are accustomed to getting most of our food today either in cans or in paper or cardboard, which I will lump together, or in plastic films. These containers serve a very useful function in keeping our food clean and bacteriologically safe.

Now, to make a container of metal, paper, or plastic, you have to do certain things, to get a technologically acceptable product. In other words, you want a piece of paper that will hold together and not spill the contents while you are carrying them home. In making these containers, there are certain chemicals that are used, and some of these in very small amounts migrate from the container to the food. These are called unintentional additives and I daresay that 90 percent of the problems brought to the Food and Drug Administration have to do with the unintentional additives rather than the intentional ones. It is these problem areas of unintentional additives in which the concept of tolerances has proved to be both necessary and desirable.

I think water pollution is more in the category of the unintentional additive than, say, the intentional food additive. No industry puts something in the water deliberately unless it is a part of water treatment or fluoridation. Rather, industry is putting things in the water unintentionally. The technological use of the water is one thing, and in the course of that use there have been materials added to the water. This is a problem of probably unintentional additives. I doubt very much whether one could completely exclude all such waste products from the waters, waste waters, at a cost that we would be willing to bear. Therefore, I personally feel that our goal is to reduce to as great an extent as possible the amount of contamination of water by waste, and certainly to reduce it to that point where there is no health problem involved.

**Mr. FABER.** There is another question, very similar to the original question asked of Dr. Zapp. This one is from Dr. C. N. Sawyer of Metcalf & Eddy, addressed to Dr. Pearson, and you may wish to comment a little further: ***"At the present time it is being suggested that the chloroform extractable test be used as a measure of carcinogenic properties of water or industrial wastes in much the same way as the coliform test. Do you see any hazard to the acceptance of such a test in regard to hampering research in this area?"***

**Dr. PEARSON.** I think that question should have been directed to Dr. Zapp. I am not at all competent to comment on the use of the chloroform extractable determination for carcinogenic properties. I am not either a chemist or a toxicologist. However, there are two engineering aspects of that question that I might just comment on.

If I am correct chemically, in assuming that chloroform extractable determination will also recover from sewage or the waters a fraction of the ether soluble material, then the problem of physically sampling and characterizing the material is going to be extremely difficult. This is well recognized by workers who have had to deal with the so-called ether soluble or grease determination, simply the method of obtaining a sample of the waste material may affect the results several hundred percent.

Then the second engineering aspect of this question is whether or not, if you obtain information related to carcinogenic properties of the chloroform extract, is this comparable or could this serve the same purposes as the coliform determination in assessing possible safety or risk associated with the use of water?

I think a lot of research would have to be done to establish a relationship between carcinogenic reaction in humans and the presence of defined concentrations of the chloroform extract, because this is the kind of basis that was developed for the use of the coliform determination.

When the coliform water quality standards were established, prior to recommendation of the levels we now use, there was a lot of work done attempting to relate disease rates with coliform concentration in the water supply. This may have been empirical, but nevertheless it was done, as well as trying to obtain estimates of the ratios of coliforms to pathogens. So there appeared to be a defined correlation or empirical relationship between disease rates and coliform concentrations as of that time.

From an engineering standpoint, if you are going to use the chloroform extract test for carcinogenic activity, you would have to establish first such a relationship of this type to use it. I don't know whether this will discourage research. If there is interest it this, someone ought to do a lot of research to resolve the question.

**Dr. LEAKE.** There is a point here of very great theoretical importance, however, which is that the carcinogens are of such a wide nature that certainly simple chloroform extracts would not give much of an indication regarding those that are water soluble or absorbable or those that might be radioactive.

**Dr. BISHOP.** Mr. P. J. Weaver, of Procter & Gamble, asked to make a short statement.

**Mr. WEAVER.** In view of the fact that questions concerning synthetic detergents were raised several times during the principal talks this morning, I would like to make a brief statement on behalf of the soap industry.

The Association of American Soap & Glycerine Producers, Inc., five years ago organized a group of firms interested in problems of synthetic detergents in relation to sewage and water treatment. The group consisted of both members and nonmembers of the association. It was originally called the Technical Advisory Committee and, more recently, the Technical Advisory Council.

Over a period of years, it raised among its own members about $300,000 to carry on a number of programs of research in universities on these problems. Results of most of these studies have been reported in the literature.

The principal direction of the activity has been the effect of ABS and phosphates on the operation of sewage treatment plants and on water supplies after the industry's products have been used in the home.

This work has been valuable to everyone dealing with the problems of synthetic detergents in respect to sewage and water treatment. Many of the early assumptions have been proven erroneous and there has been considerable modification of informed viewpoints as expressed in the literature. Some of these accomplishments are the following:

1. The concentration of ABS (alkyl benzene sulfonate) in water can be more accurately determined now than formerly because of a new method of analysis developed through this activity.
2. It has definitely been proven that synthetic detergents as found in sewage do not destroy the bacteria which decompose sewage. Originally, there was a reverse theory.
3. Synthetic detergents are degraded to the extent of 50 percent or better in the sewage treatment processes employing secondary treatment. Some opinion was formerly to the contrary.
4. ABS as found in water supplies creates no toxicity hazard. This has been substantiated by two-year animal feeding studies at 1,000 and 5,000 parts per million. Reference was made

> this morning in one paper that most toxicologists believe that a hundred-to-one ratio of extrapolating animal results to man is sound. On that basis the threshold level would be at least 50 parts per million, and very possibly it would be higher. Previously there was a gap in the knowledge of the safety of water supplies containing ABS.

The work of the Technical Advisory Council is continuing. A two-year program of research has been set up to determine the chronic toxicity of ABS on a second species of animal—dogs.

The association and its members realize the importance of the problem of water supplies to the entire people of the country. It intends to cooperate to the fullest in the effort to determine factual information and to protect the water supplies of the country.

**Dr. BORUFF.** Is it true that the soap industry has developed a new detergent which is just as good as the one now used, but only 50 percent is eaten up in the treatment plant, and that this new detergent will be eaten up in the sewage treatment, but it is more expensive? Is that gossip true or false? I would like your comments.

**Mr. WEAVER.** I would like to speak in response to that question, not as a member of the Soap Association but as a representative and employee of Procter & Gamble.

The Procter & Gamble Co. is working on this problem and has asked its suppliers to work on developing a new surface-active agent which would be degraded to a greater extent than the 50 percent or better of the present ABS material. We are doing this at the most rapid pace possible. At this moment, to our knowledge, there is no such material commercially available in the United States but we are working on it.

**Mr. KOMLINE.** (T. R. Komline, Komline-Sanderson, New Jersey). Do you have nonfoaming material? I have seen reports of it in the English literature, and I am wondering.

**Mr. WEAVER.** No foaming?

**Mr. KOMLINE.** Yes. I was hoping you would comment on this. There was one aspect which you didn't cover, and this may be the one that is going to be most critical when you finish. That is the aspect of physical chemistry. Most of these detergents are what we call anions. They are negatively charged particles and the housewives of this country are today pouring some hundreds of millions of pounds of anions into these waters or sewages, and the treatment of them is becoming more difficult because actually the matter of treatment is a matter of conglomeration of positive and negative charges, plus other factors which we don't understand, and an important question to be answered is: Could you possibly manufacture a nonionic detergent so you would not be upsetting, let us say, traditional or classic sewage treatment or industrial waste processes?

**Mr. WEAVER.** There are many nonionics on the market today, of course. They are generally used for different purposes. Some are called nonfoam, some will foam. I would just like to say that because a material is a nonionic agent as opposed to an anionic, while at high concentrations, it may not foam, this may not necessarily hold at the low concentrations we are concerned with.

**Mr. KOMLINE.** We don't care whether it foams or not. It has to do with the phenomenon of conglomeration which is being hindered by the anions that are being put in the sewers.

**Dr. BISHOP.** We would like to hear now from Dr. Heukelekien, from Rutgers. You would like to make a statement?

**Dr. HEUKELEKIEN.** I would like to make some comments regarding some of the excellent papers that were presented this morning, regarding the research needs.

We have been dealing with two types of problems: namely, dilution from chemical sources, the exotic chemicals, their identification, their removal, and their effects, which raise a number of important research problems. In addition, there has been reference made on bacteriological pollution. Yesterday several speakers stated that we have licked the problem of public health hazards from use of polluted sewage water. We can very well be proud of that accomplishment. I am not raising any question regarding that fact. There are a host of problems that Dr. Pearson raised in relation to bacteriological dilution which need further investigation: the bacteriological standards and their relation to public health; the quantitative and qualitative aspects of the bacteriological standards and their relationship to pathogens that he touched upon this morning lightly, in relation to the incidence of enteric disease; the relationship of the indicator organisms to the number of pathogens in relation to the incidence of enteric diseases.

What I want to emphasize is the validity and a critical analysis of the present bacteriological standards based on coliforms which have become rigid through the years and ossified and have been accepted as the final indicator organisms. The applicable of bacteriological standards to sewage treatment plant effluents in some States is the absence of coliforms in 1 milliliter of effluent. It would be very easy to show that by the time you bring the number of coilforms down to that level, you would have to use thousands of liters of water in order to get that one pathogenic bacteria, such as typhoid or dysentery organisms.

The more important question in my mind is the public health hazards of virus diseases rather than these common, nonexistent, or very minor diseases, such as the dysentery and typhoid.

Then the application of these bacterial standards to industrial waste has assumed ridiculous proportions, where an industry without any sanitary sewage is expected to abide by these same bacterial standards based on coliforms in sewage effluents.

I could amplify this further with some personal experience, but time will not permit it.

Then the quantitative application of coliform organisms to bathing beaches, drinking water supplies, as well as individual wells. This is a point that was raised by questions from the audience. We have completely neglected the problem of pollution of individual well water supplies. We use the same arbitrary empirical standards that were developed for municipal water supplies to apply to individual well supplies.

**Mr. FABER.** One further question addressed to Dr. Boruff relates to what Professor Heukelekien pointed out. It might be of interest to comment on it. The question was asked by Dr. T. E. Larson, of Illinois State Water Survey, Urbana, Ill., who asked: "***What is your feeling on the use of uniform national standards of water quality to control pollution?***"

**Dr. BORUFF.** No national standard would fit every situation unless it was entirely too lenient for most situations. Currently, some of our streams not polluted by municipalities and industry, would not fit these standards. An example is brackish water. To me, water quality criteria standards should vary from stream to stream and from one reach of river to another reach of river, depending upon the reuse of that water at the various localities along that stream. To me, in the main, these standards for various reaches, various streams, depending upon downstream use, should be set at State levels with some coordination of the work at Federal level, if they must be introduced.

**Dr. LEAKE.** I feel strongly impelled to make just a couple of general remarks. One has to do with the importance of oil which I mentioned as a contaminant of water. An essential need is really for research on this problem. We will have to go to ecological levels, because of the far-ranging implications.

The other matter that I wish to comment on is this. I think everyone has been appalled at the estimates that were made as to the amount of money required over the next 10 years to assure us of the quality of water we need for drinking purposes, for bathing, or for industry—$10.6 billion over the next 10 years. I want to point out that that is by no means too high a figure, and it would seem to me to be reasonably attainable if each community would do its part.

I call attention to the report that was made last year in New Jersey. The State of New Jersey has spent an average over the past 10 years of about $30 million per year for sewerage facility projects and water purification with resulting tremendous improvement in the characteristics of the three main drainage basins of the Raritan, of the Hackensack, and of the Delaware. Now, if every State could do its proportionate share (New Jersey is a small State), we could meet the amounts that have been suggested. The major sums involved in the New Jersey expenditures came from industry itself, because it had to have good water.

## PANEL IV, Afternoon Session

### **Dr. Gordon M. Fair** ***Presiding***

In opening this afternoon's meeting, I would like to thank my co-chairman, Dr. Bishop, for conducting the meeting in my absence this morning.

The awareness of American public authorities to water pollution reaches back no more than the Biblical span of man's life. Then, toward the end of the 19th century, as today also, it was the growing urbanization and industrialization of the Nation that forced the attention of the public on the need for protecting "the purity of inland waters." Then, as today again, it was recognized that the problems of water pollution were so complex, so varying, and so many, that existing knowledge was not enough for their solution; that existing knowledge would have to be expanded in pace with the quickening water requirements of the country; and that only by the synthesis of a great variety of subjects requiring for its achievement "the organic cooperation of specialists under inspiring leadership" would satisfactory progress be attained. Then, as today, therefore, it was realized that men were wanted to carry on the necessary researches, that money and facilities were essential to the success of the research program, and that men were wanted, too, for leadership in reducing the discoveries of the laboratories to practice.

First the State, and later the Federal Government, was asked to conduct fundamental and applied research, in laboratory and field, on the relation of water pollution to the development of water resources for municipal and industrial uses and on the sanitation of water supplies for the prevention of enteric disease. The achievements of the generation that accepted the challenge of its day were magnificent. So great were they, indeed, that by the end of the first third of the 20th century, the machinery of public water control could settle into the grooves of more or less complacent routine.

Then came "the great leap forward" in population and in science and industry of the midcentury. Faster than seemed believable, the industrial revolution of our age intensified the competition for water and, at the same time, its degradation by ever-growing and ever-varying pollutants ranging from thermal factors through inorganic substances to organics of such construction that they cannot be metabolized by the scavenging hosts of microorganisms. Parenthetically, it is these biological workmen to which we look for returning our lakes, streams, and tidal estuaries to natural cleanliness by themselves or for removing even the most fractious substances committed to water by household and manufactory in treatment works constructed so as to provide the most favorable environment for the operations of these beneficent microorganisms.

Once again, therefore, we are confronted by great change; change that demands of us the concurrent creation in adequate numbers of specialists and leaders and the stimulation of research that through analysis, synthesis, and reduction to practice will develop the technologies of water pollution control that are promising of success today.

To provide the sophistication needed for a successful discussion of resources, research and training for water pollution control in our times, the roster of specialists that has been attached to this panel includes not only sanitary engineers, those sons of Martha who busied herself in the kitchen while Mary sat at the feet of the Lord, but also biologists and chemists, physiologists and toxicologists and economists and political scientists; not only figures from universities and government agencies, but also leaders in industry and men of affairs.

It gives me great pleasure to welcome them to the task that lies before and to invite the audience to lend careful ear to the formal discussions and give vigorous voice in the forum that will follow this afternoon.

The first speaker this afternoon was to have been Dr. Rolf Eliassen, Professor of Sanitary Engineering, Massachusetts Institute of Technology. Unfortunately, he was snowed in even more thoroughly than I, so he isn't here. I have asked Dr. John Geyer of the Johns Hopkins University to read his paper to us.

# Research and Treatment Technology

DR. ROLF ELIASSEN
***Professor of Sanitary Engineering***
***Massachusetts Institute of Technology***

The first paper on this panel has discussed the changing characteristics of municipal and industrial waste waters. This paper is concerned with the challenges facing the sanitary engineering profession in coping with these changing characteristics and with the higher degrees of treatment demanded by the increased use and reuse of the water resources of this country.

What are some of the contaminants to which further attention must be paid? These contaminants fall into three categories: (1) Those which will not be destroyed in waste water treatment plants, even secondary biological treatment plants; (2) those chemicals which the receiving body of ground or surface water cannot purify; and (3) those which the water treatment plants processing ground or surface waters cannot remove to below the tolerance limit of the water consumer.

In the first and second categories are those chemicals which may be toxic to the biological population of the treatment plant or streams, or those organic chemicals which the bacteria cannot consume. Nature's own self-purification processes, used in biological (secondary) waste treatment plants and streams, are part of the wonderful cycle mentioned by the writer of old, "from dust ye came, to dust ye do return." The dilemma of our streams is that man has defied nature by synthesizing many new chemical substances which nature cannot "return to dust." Some of the new synthetics may be toxic to bacteria while others cannot serve as bacterial food. In either case, the chemicals are not destroyed as they should be in the dynamic waste treatment processes which exist in streams.

The third category of contaminants will include many of the salts from municipal and industrial waste waters, as well as all of the soluble organic substances which have not been destroyed in the stream or removed in the ground. Conventional water treatment processes are not designed to remove soluble salts such as sodium and potassium chlorides, sulfates, and nitrates. Only calcium and magnesium bicarbonates may be removed by the lime softening process used in so many cities. The other salts take a far more costly process of demineralization for their removal and municipalities cannot be expected to stand such expenses. The removal of salts and excess soluble organic substances must be accomplished at the source of the wastes—at the industrial plants which produce them, or at the municipal waste treatment plants through which these wastes pass before being discharged into the ground or surface waters.

Water filtration plants are not capable of removing viruses. As a matter of fact, very litle is known about the viral contamination of ground waters or streams, nor of the fate of viruses in the water environment. Much research is needed in this field, perhaps taking advantage of modern radioactive tracer techniques to tag viruses and follow their behavior.

What is the effectiveness of existing waste treatment methods on contaminants presently discharged into streams? Considering municipal waste water treatment plants, these are designed first to remove visible solids which can be screened out or will float or sink in a skimming and settling tank—known as primary treatment. Many of the waste water treatment plants for cities on the great rivers, such as those on the Ohio and Mississippi, and those planned for the Missouri, utilize primary treatment. Removals of organic substances from the liquid phase are in the range of only 15 to 30 percent. The principal purpose of these plants is to remove objectionable solids which might settle or float in the stream and give rise to nuisances. The stream itself is expected to complete the oxidation of organic matter by biological means.

On smaller streams it is necessary that the waste water treatment plant accomplish a greater removal of organic matter. Secondary treatment is designed to remove finely divided dirt particles and organic matter, present as colloids, and also some soluble organic matter. The secondary processes utilize biochemical units in which bacteria and other microorganisms consume the organic matter as food and thus destroy it.

You may have seen circular rock beds on which rotating arms sprinkled sewage (biological filter beds), or tanks into which air is blown to furnish oxygen for bacterial metabolism (activated sludge aeration tanks). Organic residues, known as sludges, removed in settling tanks are sent to anaerobic digestion tanks in which microorganisms accomplish further destruction of organic matter. As in streams, these are nature's processes, accelerated by man's engineering works, but limited by the ability of nature's organisms to consume only certain types of organic substances, particularly fats, carbohydrates, and proteins which constitute human wastes. These are removed up to 90 percent before discharge to streams.

Many of the newer synthetic chemicals, the so-called exotic chemicals, such as some of the detergents, germ killers, insecticides, herbicides, solvents, and others are not subject to bacterial degradation when present in solution in municipal and industrial waste waters. Thus they pass unchanged through treatment plants to watercourses and unchanged through water treatment plants to consumers.

Added to this, the farmers of the Nation are applying vast tonnages of insecticides, weedicides, and pesticides to the land. Percolation of rainwater into the ground and runoff to streams contaminate both ground and surface water supplies. Industries, such as the vast new petrochemical industry, are discharging organic residues from the production of these exotic organic chemicals into some streams. These are not even detected by present conventional means of water analysis. How much of an increase can our watercourses take in the face of the exploding population and expanding industries of the Nation? The medical profession is seeking an answer to this. Meanwhile, our currently accepted waste water treatment processes are not adequate to handle the expected increases of organic pollution of the decade ahead.

Methods of removal of inorganic salts are available commercially, but they are expensive. Demineralization for salt removal may be accomplished by ion exchange, electrodialysis, and evaporation. Some of these have not been applied to waste waters and would have to be studied in the laboratory and the field. In most instances these processes would have to be added as tertiary units at waste water treatment plants.

Most radioactive substances fall into the category of salts not removed by water or waste water treatment plants. Radioactivity will not be considered as a serious problem in this paper because this new industry is regulated by State and Federal laws. These prevent the discharge of radioactive wastes to streams or the ground in any concentration which will approach the tolerance value of the public.

Adsorption, extraction and distillation are unit operations available for removal of synthetic organics. But it is hardly logical nor economical to expect municipalities to bear the expense of such complex tertiary treatment unless there is no alternative. This might occur if the sources of chemical contaminants in streams were so diverse that treatment at the source could not be practiced. Much research, experimental studies and pilot plant work must be done to determine (1) the identity and characteristics of the stable contaminants unaffected by biological degradation processes; and (2) the most feasible design of waste water treatment plants to accomplish their removal.

Presently all that is known is that stable organic residues are found in rivers used for water supplies in concentrations of parts per billion. These are being extracted on activated carbon filters. Although small in concentration, they lead to odors now. But what can be predicted about the fate of the contaminants in watercourses, the effects on water quality, and public health with increasing concentrations which are bound to come? Research by the sanitary engineering and medical professions can supply the answers, and these must be obtained soon.

If conventional water conditioning processes are inadequate to decontaminate water containing excessive quantities of exotic organic residues, even though only in parts per billion, new processes must be investigated by research teams of scientists and engineers of several disciplines. Activated carbon works well in the laboratory as an analytical extraction tool but it is to be hoped that more economical processes could be developed by men skilled in the fundamentals of chemical and biochemical processing of water supplies and waste waters.

In order to leave no stones unturned, this Conference must ask the chemical industry: "What are the chances of changing the character of the synthetic chemicals which contribute to water contamination?" The old-fashioned soaps were completely destroyed by microorganisms in waste treatment plants and streams so that no problems were encountered in water treatment plants. Synthetic detergents, as presently distributed to domestic consumers, are only partially degradable by microorganisms, due to the configuration of the detergent molecule. It should not be difficult for the chemical industry to develop a different series of compounds and produce some which could be broken down, and still be relatively inexpensive, as are the present soaps and detergents. The same might be done for many other synthetic organics which contribute to the water pollution problem. One of the criteria of acceptance of many new chemicals by the public of the future may well be the ability of microorganisms to break down the synthetic organics and thus prevent the cumulative effect of these in our water resources.

Industries will have to do extensive research on the recovery of salts and organic residues within their production processes. Perhaps research can devise means for the utilization of these waste products. The only alternative is to install elaborate treatment processes at industrial plants to curtail the discharge of those wastes which streams, water and waste water treatment plants and consumers cannot tolerate.

## Summary and Recommendations

Summarizing, modern waste water treatment methods, as well as water purification plants are ineffective in the removal of many soluble salts, including radioactive materials and complex organic substances presently contaminating streams and water supplies. Tertiary treatment processes are known or could be developed for installation in municipal waste water treatment plants, but at great cost to the taxpayers. This paper has discussed other alternatives which are presented in the form of recommendations.

In the cases where synthetic organic chemicals, such as detergents, are widely used in households, it is recommended that the petrochemical and chemical industries direct their research toward the production of synthetic organic compounds which can be destroyed in conventional municipal waste water treatment plants using secondary processes such as activated sludge. These processes are 90 percent effective in the removal of most organics, including soaps normally found in domestic sewage, but are ineffective in destroying the more exotic synthetics, including most household detergents.

It is also recommended that:

1. Research be performed on the behavior and fate of modern organic contaminants in the water environment.
2. Virus research be expanded to include the incidence of viruses in municipal waste waters, in surface and ground water supplies and the effectiveness of water and waste treatment plants in the destruction of viruses.
3. Research be initiated to develop more effective means of removing pollutants from water in municipal and industrial water treatment plants.
4. More effective process controls of industrial waste discharges be developed.
5. The recovery or utilization of industrial process wastes be given greater consideration as a means of preservation of water resources.
6. More sophisticated industrial waste treatment processes be developed through research in order to prevent excessive stream contamination from complex organic substances and inorganic salts which can neither be recovered nor utilized.

## DISCUSSION

### RICHARD HAZEN

***Partner, Hazen and Sawyer, Consulting Engineers***

Professor Eliassen has called attention to three types of contaminants to which we must give further attention. He listed contaminants not destroyed in waste treatment plants, those not destroyed in the receiving waters, and those which water purification plants cannot reduce below the tolerance limit of the water consumer. The first two categories are essentially the same because, for the most part, our present-day treatment processes are accelerated versions of natural processes in receiving streams. Whether or not we accomplish the desirable removals in the treatment plants is usually a matter of economics.

The third class of contaminants, which includes the detergents, synthetic chemicals, radioactive wastes, and so forth, is of course the one giving the most concern. We are concerned not because the immediate concentration of these wastes is perilous, but because we do not know the long-range effects of these contaminants. We may not know some of these effects for generations. It is obvious that the treatment or elimination of these wastes will require much research of the highest caliber—of the caliber that produced these new chemicals in the first place—and this research unquestionably will cover the full spectrum of scientific technology. However, two features of the problem seem quite clear:

1. We must first attempt to establish quickly and as definitely as possible which of these compounds are truly harmful and their allowable concentration. This is primarily a problem for the chemists, the physiologists, and doctors. We must catalog these wastes as safe or unsafe and set up a special category for the doubtful items. The list of doubtful items is likely to be long for many years to come, but we must make a start. And the unsafe and doubtful wastes must be kept out of our waters.

2. These hazardous wastes are nearly all of industrial origin, and are the byproducts of manufacturing and chemical processes. It is clearly the duty of the manufacturer to find the solutions to treatment of these wastes. If the waste disposal problem is extremely difficult the cost should be and will be reflected in the cost of the final product. In some cases the cost of treatment may be so great that we will decide to get along without that particular product.

It is unfair to discharge such wastes to the municipal sewage treatment plant and ask the public to find ways to treat them. Furthermore, it is obviously uneconomical to put 5 million gallons per day of municipal sewage through a number of special processes in order to take care of 100,000 gallons per day from an offending industrial plant. This is not to say that all industrial wastes should be excluded from municipal sewage treatment plants. Often where the industrial waste is amenable to the processes used in the municipal sewage treatment plant just the reverse is true. However, the burden of proof must be upon the industry. Municipalities eager to entice new industries into their midst must guard against the temptation to issue "carte blanche".

For ordinary municipal wastes we now have treatment processes which will reduce the suspended matter and organic pollution to almost any limits that may be required. How far we go is again a matter of economics and frequently depends upon how much natural treatment we can count on in the receiving waters. As noted by Professor Eliassen the treatment provided in ordinary sewage and waste treatment works does not reduce the dissolved solids and if the water of a stream is used over and over again the dissolved solids increase with each use. Except in a few heavily industrialized areas of the country and in a few arid areas where water is employed extensively for irrigation, the increase in dissolved solids has not proved a major barrier to water users. Ordinary softening of water for removal of calcium and magnesium suffices in most instances. More complete processes are used for boiler-feed water and other special uses. Rapid increases in dissolved solids are likely to result from industrial processes rather than from increased population and domestic sewage. Ultimately it may become necessary in some parts of the country to limit the quantity of the dissolved solids discharged into receiving streams. Some of the State codes governing the treatment of sewage and industrial wastes already have limits, but these usually apply to the concentration of the waste itself, rather than to the total quantity of waste which will be permitted in the receiving waters.

The cry for more and better research in waste treatment stems largely from the fact that there have been no really basic changes in waste-treatment and water-treatment technology for almost 50 years. There have been many improvements in technique which have yielded better effluents at lower cost, but the processes remain substantially unchanged. This is perhaps not surprising since the treatment processes we now employ are essentially natural processes.

It seems to me that research in the treatment of municipal wastes should be directed along the following lines:

1. To search for catalysts—chemical, physical, and biological—that will speed up the natural processes now used and permit construction of much smaller tanks and equipment.

2. To explore thoroughly the possibilities of chemical treatment, or chemical and biological treatment using new chemicals and new strains of bacteria.

At the same time practical research and development work must be done to improve the handling of raw sewage, screenings, grit, and so forth, and to provide economical dewatering and disposal of sludge. Most of us active in the sewage-treatment plants rarely operate with the smooth precision of chemical and metallurgical plants. It is obvious that we will not approach such routine operation until we have found ways to remove the highly variable solids and trash in the sewage as it comes to the treatment plant. When we can feed raw material uniformly to the chemical-biological processes we can hope for automatic and consistent performance.

In closing I want to emphasize that sewage and waste treatment is only one of the many social demands on the economy and taxpayer. Adequate control and treatment of exotic and other unusual wastes and more complete treatment of ordinary sewage is going to be expensive. In establishing over-all requirements for any area or stream we must take advantage of the natural purification available in the water. If through the workings of pollution control agencies we insist upon treatment to a particular degree or removal of certain substances simply to conform to a code or regulation without consideration of the receiving waters, we are undertaking an unnecessary burden.

# Resources for Research and Training

DR. R. KEITH CANNAN
***Chairman, Division of Medical Sciences***
***National Research Council***

This panel is concerned with the delineation of unsolved and emergent problems that are arising from the increasing pollution of the waterways of the Nation. My task is to open a discussion of the ways and means whereby we may mobilize the resources in manpower, facilities, and funds that will be needed to promote the search for solutions to these problems.

Much of my life I have been preoccupied with training and research in the broad field of the medical sciences. I am, however, essentially untutored in the academic and professional patterns of the engineers who manage our waterways and am, therefore, insensitive to their traditions, their prejudices, and their idiosyncrasies. Sometimes, however, one who peeks in from without may see things a little differently from one who looks out from within. In this spirit, I will try to sharpen focus on the issues before us today against the background of the experiences and frustrations of medicine.

After all, medicine and engineering share primary responsibility in the field of sanitation. It used to be a truism that the engineer labored to adapt the environment to man, while the physician played the complementary role of adapting man to his environment. I am not sure that this is valid today. The engineers, chemical, mechanical, and electrical, are now to busy modifying man's natural environment out of all recognition that they have little time to consider the effects of their enterprises on man's essential well-being. They leave to the sanitary engineers and medical guardians of the public health the task of tidying up after them.

The science and art of controlling the water resources of nature for the service of man have, historically, been the province of engineers. Indeed, the specialty known as sanitary engineering achieved professional coherence and identity when it assumed responsibility to the community for the supply of clean water and for the disposal of water-borne wastes. Many other specialists and technologists contribute to particular aspects of water control, but I doubt if there is any question that it is the sanitary engineer who is best equipped by training, skills, and experience to see the problem whole and to give direction and leadership to research and development.

Let us, then, begin our enquiry with an examination of the current and prospective supply of and demand for sanitary engineers. The data that I will examine have been given to me by the Division of Engineering Services of the Public Health Service.

A recent census of practicing sanitary engineers measured up like this:

| | |
|---|---|
| In public health agencies | 1, 324 |
| In public works agencies | 1, 090 |
| In military agencies | 445 |
| In industry or private practice | 2, 340 |
| In universities and colleges | 337 |
| | 5, 536 |

About two-thirds of these—i.e., some 3,700 sanitary engineers—were said to be engaged in one way or another with water-supply and water-pollution control.

This is not a large company. The water works industry encompasses some 18,000 utilities serving close to 140 million consumers. It has a gross annual revenue in excess of $1.4 billion. One concludes that the waterways of the Nation are served by an average of one sanitary engineer per community of 40,000 persons and one per $400,000 of revenue from water services. In these figures I see no evidence of overstaffing or featherbedding.

Turning now to the question of recruitment for the future, we may first accept an irreducible annual need of 280 newly trained men to maintain present strength. This is based on a 5 percent loss per annum by retirement, death, or defection.

Beyond this, it may be argued that an additional 100 a year are required so that the cohort of sanitary engineers may grow in size in proportion to the Nation's growing population. Finally, reflecting the theme of the present Conference, we must recognize that technological innovations in man's environment are constantly raising new problems and opening up new areas of practice for the sanitary engineer. What expansion of force will be needed to meet these new tasks I must leave to the estimation of the experts. The Public Health Service has offered the figure of 350 a year. By analogy with medicine, the need is modestly stated for the field of sanitation probably faces the same paradox as does medicine—the more successful is its practice the greater is the demand for its service. The great successes of medicine in the control of infectious diseases and infant mortality, in the expanding power of surgery, and in the cure of deficiency diseases and endocrine disorders—these successes have not reduced but have increased the demand for medical service. A patient cured of acute disease becomes a candidate at some later date for care of those ills of mankind that accumulate with age. Likewise in the field of water resources, it would seem to me that the demand will ever be for more water to support more people to produce more waste to pollute more water. We must run faster and faster merely to remain in the same place.

If, then, we accept as conservative estimates of an annual need for 280 new sanitary engineers for replacement, and of 450 more to match the increase in population and to cover new areas of service, we are, in effect, planning to double the professional population in 12 years. In the face of growing competition for the prospective scientific talent of the country, this may prove to be hard to achieve.

What is the Nation's capacity for the training of sanitary engineers? First, I think we must agree that our thinking should be in terms of graduate training. The undergraduate education of the engineer, like that of the physician, must be broad and general, comprehending the elements of all aspects of practice. Specialization and the study of particular areas in depth must perforce be a graduate experience. Some degree of specialization, even within the limited area of sanitary engineering, is however, essential before a man can assume a position of professional responsibility in the community. A canvas of government agencies indicated that for 84 percent of the positions available for sanitary engineers, these authorities sought men with graduate training no less than that required for a master's degree. For leadership in practice, teaching, or research we may well agree that engineering, like other scientific professions, has reached the stage of development at which a doctor's degree will be the accepted symbol of superior quality.

The current annual output of sanitary engineers by the engineering schools is about 300. This, be it noted, is about equal to the rate of depletion of the ranks of active practitioners. However, only about 130 of these have earned a master's degree and less than 10 have achieved a doctorate. Moreover, some 25 percent of these men with graduate experience are foreign nationals, and so we come to the sorry conclusion that the current annual output of men with significant training in depth in one or other major area of sanitary engineering is a bare 100. This is far short of the annual depletion of the ranks of active professionals. It does not begin to meet the estimated need for expansion.

Where lies the bottleneck? Some 68 schools offer graduate training to the level of the master's degree in one or more branches of sanitary engineering and 36 will accept candidates for the doctorate. Unfortunately, the ability of most of these schools to deliver is on paper only. Sixteen schools are responsible for 90 percent of the graduate output, 15 average less than three master's degrees a year, and 18 have awarded none in the last three years. This, surely, is a melancholy record. A survey of 45 of the 68 schools was made in 1958. The staffs in sanitary engineering totaled 192 engaged in teaching and 149 more in research with nominal teaching responsibilities. This gives an average of some four teachers per school and 1.7 graduate students per teacher. It is little wonder that the average annual cost per student was placed at $3,500.

The schools exist. Why are they so poorly populated? The universities of the Nation award about 60,000 master's degrees a year. Of these, 5,400 are in engineering and 17,000 in the physical or biological sciences. It is only too evident that sanitary engineering is losing out badly in the competition for professional talent. At the level of the doctorate the situation is even more disturbing. Of the 3,000 odd doctorates awarded annually in science and engineering, less than 10 have been majors in sanitary engineering.

It is evident that there is lacking in students of engineering and science any lively motivation to enter the field of sanitation. Motivation toward a particular career is compounded of many factors—anticipated economic rewards, family tradition, social prestige, the opportunity for adventure, intellectual satisfaction, and so forth. Of these, the intellectual appeal of a vocation is in my opinion a more potent force than the prophets of a materialistic culture may be inclined to concede. Certainly it is the one that the schools can most directly cultivate. That department within a school that most vibrantly radiates an intellectual and professional excitement for its specialty is the department that will attract the best students. Lacking this, all your fellowships, traineeships, and other devices to spur recruitment to specific fields of endeavor can be only palliative.

This has been the experience of medicine. The student demands an intellectual foundation for practice. As scientists, we persuade him that he will find this most surely in the logic of controlled observation and experiment. In general, it has been those departments of medicine that have affiliated closely with the departments of the preclinical sciences or have developed laboratories of their own that infuse their teaching with the spirit of enquiry as well as with the spirit of practice. These are the departments that fire the imaginations of students and capture their loyalties.

The practitioner in the field of environmental health operates both in the area of engineering and of public health. He has one foot in the physical sciences and one in the sciences that are the foundation of medicine. In most schools of engineering the intellectual climate reflects preoccupation with the physical rather than the biological adaptation of the environment. The faculty of sanitary engineering is a small and rather lonely enclave set apart from the mainstream of scientific interest of the school. It has limited access to the undergraduate student and must seek to encourage him to apply his developing skills to the service of public health in an atmosphere unsympathetic to his enthusiasms.

The few schools that have been most effective in recruitment to sanitary engineering have been strong schools of engineering that have established a close rapport with schools or institutes of public health or of preventive medicine. Not only does the climate of interest in such schools infuse the young engineer with interest in biological concepts, but provides a means of broadening the base of recruitment to include that large body of students that are majoring in the life sciences.

The technology of sanitation is increasingly calling on the cooperation of microbiologists, immunologists, physiologists, toxicologists, and radiobiologists. Its future effectiveness requires close integration of the concepts and skills of the physical and biological sciences. The logical way to achieve this is to encourage the development of schools that assemble these varied disciplines in a united faculty and that combine in a common fellowship undergraduates in the life sciences and in engineering.

It is my thesis that the authorities responsible for the promotion of research and training in sanitary engineering should concentrate their efforts on strengthening and multiplying the type of academic institution that I have described. Considered estimates should be made of the additional facilities and funds for student support necessary to allow existing schools of this type to expand their enrollment significantly. Consideration should then be given to identifying other schools capable and willing to develop comparable institutions and to determining the funds required to provide the necessary construction, faculty and student support training grants, and so forth. Due consideration should be given to geographic distribution in relation to population density. The principle of this proposal is simple—better a dozen virile institutions than 50 ineffective ones.

Although the title of this paper is "Resources for Research and Training," it has been preoccupied with the need for men rather than with the need for research. The emphasis has been deliberate. The essential resource for research is men with the instinct for enquiry, men trained to ask questions and to devise experimental approaches to finding their answers. It is men that do research, not funds or facilities. Funds and facilities are needed to sustain investigators and to provide them with technical support and equipment; but, as I survey the contemporary scene, I am persuaded that it is not lack of facilities and certainly not lack of funds that is impeding the advancement of knowledge, but rather a lack of men pregnant with ideas.

Since World War II, society has been insistently demanding more and more research for the protection of health and, through the medium of Congress, seems to be willing to foot the bill. The progressive expansion of research support in recent years has been phenomenal, as the following figures indicate:

*Research grant funds of the Public Health Service*

| | Total health program | Sanitary engineering and occupational health | Water supply and pollution |
|---|---|---|---|
| 1947 | $4,000,000 | $66,000 | $57,000 |
| 1953 | 21,000,000 | 375,000 | 220,000 |
| 1958 | 100,000,000 | 2,250,000 | 815,000 |
| 1960 | 200,000,000 | 4,400,000 | 1,700,000 |

Be it noted that these figures do not, by any means, represent the total national effort. Industry and philanthropy, as well as agencies of Government other than the Public Health Service, contribute substantially to medical research. It has been estimated that the total national support of research in the medical sciences in 1960 amounts to about $715 million. The over-all national support of research in water supply and pollution control, during 1958, was estimated to be:

| | |
|---|---|
| Public Health Service: | |
| Extramural research grants | $815,000 |
| Intramural research projects | 570,000 |
| Other Federal agencies | 490,000 |
| State and local agencies | 1,015,000 |
| Universities | 145,000 |
| Industry | 465,000 |
| Total | $3,500,000 |

The reader will note that the Public Health Service funds for medical research in general are expressed in millions, while research projects in water supply and pollution control are given in thousands. This will emphasize the fact that the latter receive only a very small fraction of the money devoted to research in heatlh and disease—currently it is less than 1 percent.

In a recent report to Congress a committee of experts estimated that the national support of medical research could and should increase to about $3 billion by 1970 and that the Federal Government should be expected to contribute two-thirds of this amount. If we apply the same growth factor to the field of water supply and pollution control, we arrive at a national research budget of about $15 million, of which we may be sure that the major part will have to be found by the Federal Government.

In medicine in general, the committee of experts were of the opinion that the manpower to sustain the projected expansion of effort can be mobilized. It was recognized that about half of current medical research was in the hands of Ph. D.'s rather than M.D.'s and that, in the future, medicine will need to depend more and more on recruitment of investigators who do not have clinical experience.

How will sanitary engineering meet its expanding needs for investigators? At the present time, 60 percent of Public Health Service funds for research grants in water supply and pollution control go to institutions other than schools of engineering. This merely reflects the multidisciplinary nature of the problems in the field and should not be a matter for concern. Indeed, it reemphasizes the need for the type of center for training and research that unites in a common purpose men with varied physical and biological competence. The power of such an institution is evidenced by the splendid leadership in research provided by the Robert A. Taft Sanitary Engineering Center in Cincinnati.

Progress in the control of the environment, as in the advancement of knowledge in general, depends on the labors of specialists. There is, however, the continuing danger of fragmentation of effort and loss of that intellectual unity of concepts that gives form and structure to knowledge. The investigator with experience in engineering, though he be himself a specialist, seems best qualified and must accept major responsibility for the broad definition of problems and for sustaining coherence and generality of concepts.

Let us assume that research in water supply and pollution control will be able to command some $20 million in 1970 and that $20,000 will sustain the research project of one investigator for one year. It follows that it will be possible to put about 1,000 investigators to work in the field. If 40 percent of these are to be engineers, we must look to the schools to produce 400 sanitary engineers with the extensive academic training that qualifies men for research. The current annual output of only 6 to 10 doctorates in all branches of sanitary engineering is far short of meeting the need.

The sums of money that we have been playing with seem large to some of us, bred in an older tradition. They are, however, minutely small in relation to the gross national product. Meeting our research needs would be easy, were money the only problem. The task of society, and of the professions that serve it, is the harder one of enticing the best minds of the youth of the country to join in the task of cultivating man's natural resources and promoting his welfare. Intrinsic to the problems we are facing at this meeting is the growing feeling of a need for a redefinition of our national goals that will raise the dignity of intellectual effort in the service of society above the transient physical satisfactions of conspicuous consumption.

**Dr. FAIR.** Thank you, Dr. Cannan, for a most thought-provoking and stimulating paper. We are glad you looked in from the outside. If I had enough residual Scotch in me, I would quote that "God give us the gift to see ourselves as others see us."

# DISCUSSION

DR. GERARD A. ROHLICH

***Hydraulic and Sanitary Engineering Laboratories, University of Wisconsin***

This panel is indeed fortunate in having Dr. Cannan provide the opening remarks for our discussion on resources for research and training. You will all agree, I am sure, that, despite his claim that he is an outsider, he has revealed a depth of perception into our problems that is more keen than could be demonstrated by many of us who are immediately concerned with our manpower needs for research, teaching, and practice.

It is hoped that this Conference and others like it will bring more sharply into public focus the high degree of intellectual requirements needed, and the intellectual stimulation and interest that can be attained, by those who enter and engage in the solution of problems in the field of water pollution. This undoubtedly will provide the primary step proposed by Dr. Cannan to encourage and entice the best minds to engage in this work.

As pointed out by Dr. Cannan, our production of sanitary engineers, trained for research in the complex problems in water pollution, is woefully inadequate even to meet our present needs. Furthermore, with but a few exceptions, our universities have not had the resources to bring together, in interdisciplinary effort, scientists from such related fields as chemistry, biology, and physics in integrated programs of research and training. Even though departments in other sciences such as bacteriology, biochemistry, organic chemistry, and physical chemistry may express an interest, and even actively cooperate, in the training of sanitary engineers in fundamental course offerings, the student at the research level has need for day-to-day contact with experts in these sciences, whose primary interest is in research in water pollution. This means, of course, that those who wish to provide research training, and the intellectual stimulation on which graduate students thrive, must maintain on their staff research-minded scientists from these related fields.

There is little question, at least in my mind, that the sanitary engineer, trained in research, is able to recognize fundamental problems in water pollution and can provide leadership in the development of basic research, but in the ultimate accomplishment of such research he encounters the need for scientists in the related fields.

Dr. Cannan has provided us with information on the number of sanitary engineers that have been trained in the past years. If we review in somewhat more detail this past training for research in sanitary engineering, it is clearly evident that we are only in the early stages of providing trained personnel, for university teaching and research, who will be able to provide the kind of leadership in the interdisciplinary effort just mentioned. A glance at table I (USPHS data) will indicate that it has only been in the last five or six years that we have had more than half a dozen Ph.D. degrees granted annually in sanitary engineering. At this moment I have requests on my desk from six different universities for men with a Ph.D. degree. I am sure that this is only a fraction of the total number of requests that have come to the various universities represented here today.

Although valuable research is conducted by those with intermediate training at the master's level, it is only fair to say that most of these men find themselves better adapted to work in practice, and, because their training is less extensive, the scope of research that they can conduct or supervise is necessarily more limited.

Dr. Cannan has pointed out that, although a large number of schools offer graduate training for the master's degree, and some 36 will accept candidates for the doctorate, the ability of most of these schools to deliver is on paper only.

Training for research at the doctorate level requires close association between the major professor and the candidate, and, regardless of the competence of the major professor, he simply does not have sufficient time to work with more than a few thesis students at any one time. It is axiomatic that we must expand our staff and facilities if we are to meet the growing need for men at the doctorate level. Initially, our responsibility lies in continually encouraging and inspiring our Ph.D. students to accept university teaching and research positions. This is the seed from which our growth will come. There is, of course, an increasing need by industry for these men with a Ph.D. degree, and we face a dilemma, since we do not wish to discourage our students from accepting such positions. Usually, industrial positions provide intellectual stimulation equal to that in the academic atmosphere and, almost without exception, offer greater financial rewards.

Often we have men who reach the M.S. level who should continue with their graduate programs but do not, simply because they cannot make the financial sacrifice involved.

It is generally agreed that our needs are (1) to increase the number of graduate teaching faculty (2) to expand research and teaching facilities, and (3) to provide, through fellowship grants, the opportunity for more extensive education and productive research for the men to be trained.

Although it has been our experience that funds can be obtained for well-designed research projects, there are many problems in water pollution which, though recognized, are not undertaken, nor are requests for funds made because the immediate manpower required to fill key positions is not available. Until such personnel are available these problems will not be given attention.

Admittedly, the problem of obtaining graduate faculty will be a slow process, but we must begin this expansion at once. One way in which this might be accomplished would be to make available to those already in the teaching profession, who have reached the M.S. level, grants equivalent to their current salaries, in order to permit them to pursue graduate work, at selected universities, and obtain research training to qualify them for the Ph.D. degree. Most of you will recognize that what I am proposing is similar to the National Science Foundation science faculty fellowship program. In the last three years the sanitary engineering division at the University of Wisconsin has been fortunate in having three teachers from other institutions supported by this NSF program. These men are married, and without the full salary support it is unlikely that they would have had the opportunity to complete their graduate training. Assuming a cost per student, of this type, of $10,000 per year, which would include, in addition to the matching salary, fees, books, and a modest sum to the school for research supplies and equipment, a program could be initiated to train 50 men for $500,000.

Most of the men selected for such a program would require a minimum of 2 calendar years of training, and costs for the second year would be almost doubled, if a new group of 50 were to begin each year. Obviously, the number of men available, who would qualify, would decrease quite markedly as the program continued, but from such a program would come a supply of teaching faculty trained in research.

Concomitant with this kind of program, physical facilities for training must be expanded. Although the program of health research facilities grants is a source of funds, such funds frequently cannot be requested by universities because of the matching-grant feature. Although many State universities recognize the desirability of expansion in sanitary engineering, they are hard pressed from other directions to provide even the classroom space and supplementary facilities for undergraduate training, and have difficulty in justifying high priorities for allotment of funds for expanded research and training facilities at the graduate level.

The project grant program for graduate training in public health does not permit funds to be used for the construction of facilities except for minor renovations and repairs. Funds should be available on an outright grant basis to selected schools for expansion of physical facilities to provide centers for research training.

Various estimates of dollar amounts required for the expansion of staff, facilities, and support of students have been made. These estimates have encompassed the broad environmental engineering field and have included water supply, water pollution, food technology, occupational and radiological health. Although a clear-cut separation of the needs for staff, facilities, and student support in the field of water pollution control cannot be made, it is well known that most of the men receiving advanced training in schools of sanitary engineering, at the present time, enter the fields of water supply and water pollution control either in teaching or in practice. Even in this narrow aspect of environmental health, it would not be unreasonable to place into training, at the doctoral level, an additional 100 men at this time with the hope that the production of trained workers could be such that the output of Ph. D.'s could be raised to about 30 to 40 a year for this area of research.

This number is not adequate to meet our future requirements, but to accomplish just this modest beginning step would require about $1.5 million a year for staff and student support. This requirement would be for training only, and to it must be added funds for expansion of facilities and increased funds for research support for the additional staff engaged in the training programs. Thus, research funds over and above those presently available will be required.

To effectively develop the interdisciplinary approach to the research required in solving water pollution problems, we have need for regional laboratories. Such regional laboratories should be established at selected universities where a staff of consulting scientists is already available. At least seven such centers should be located geographically to serve the Nation's needs for research in water pollution.

Training of graduate faculty, facilities for training and research, support for students, and establishment of centers for water pollution research will require financing on a substantial scale and the need for a flexible financial structure.

*Undergraduate and graduate degrees awarded in sanitary engineering in the United States, 1900–1958*

| Year | Bachelors [1] | Masters [2] | Doctors | Year | Bachelors [1] | Masters [2] | Doctors |
|---|---|---|---|---|---|---|---|
| 1900-34 | 1,265 | 207 | 5 | 1948 | 160 | 163 | 4 |
| 1935 | 86 | 35 | 1 | 1949 | 247 | 136 | 4 |
| 1936 | 88 | 18 | 1 | 1950 | 287 | 148 | 4 |
| 1937 | 75 | 51 | 2 | 1951 | 247 | 152 | 7 |
| 1938 | 82 | 42 | 1 | 1952 | 216 | [3] 105 (22) | 9 |
| 1939 | 103 | 51 | 2 | 1953 | 216 | 102 (20) | [3] 5 (3) |
| 1940 | 116 | 70 | 2 | 1954 | 164 | 120 (25) | 9 |
| 1941 | 98 | 68 | 4 | 1955 | 141 | 134 (34) | 11 (2) |
| 1942 | 93 | 45 | 2 | 1956 | 208 | 124 (31) | 9 (1) |
| 1943 | 165 | 24 | 4 | 1957 | 145 | 152 (39) | 11 (1) |
| 1944 | 65 | 32 | ------------ | 1958 | [4] 107 | [4] 121 | [4] 16 |
| 1945 | 40 | 33 | ------------ | | | | |
| 1946 | 28 | 60 | 2 | Total | 4,554 | 2,336 (460) | [5] 116 (13) |
| 1947 | 112 | 143 | 1 | | | | |

[1] No distinction is made between nationals and nonnationals awarded the degree. See footnotes "1" and "5."

[2] Of the total of 1,478, 1900 to 1951, inclusive, 289 were awarded to nationals of other countries.

[3] Figures in parentheses represent nationals of other countries and are included in the larger figure.

[4] Estimated.

[5] Of the total of 46, 1928 to 1951, inclusive, 6 were to nationals of other countries.

**Dr. FAIR.** I have always been under the impression that civil engineers, in view of the fact that most of their work lies in the public domain, were socially directed individuals. However, this was not brought to my attention quite as forcibly as it should have been until about five years ago, when I joined a research group on water resources which included economists and political scientists as well as engineers and mathematicians. I realized, then, that the problems that we think of as economically important in engineering are much too narrowly defined in most of our work. We need to have a much broader view of the relation of our problems to the economy of the Nation and in many instances, indeed, the economy of the world. This is so, in particular, when we talk about our water resources.

Sir Charles P. Snow, better known in this country as the novelist C. P. Snow, in England as the scientist who provided needed scientific manpower during World War II, has recently stated in his Godkin lectures at Harvard University that scientists are particularly useful in government because they are future-directed people. At first he said scientists and engineers. Then he caught himself up and said, as best I can remember: "No, I shall limit this to scientists, because, in my opinion, engineers are all too often strongly institutionalized in their points of view and not as flexible in their minds and attitudes toward the larger problems of the Nation as are scientists. They are the truly future-directed people."

I suggested that it behooves us to show that Sir Charles was wrong; however, this will take a good deal of bending of the minds of engineers if we are to do so. It is important, then, that in a conference of this type, even though it is directed toward personnel and research, we should bring in men from the social sciences to tell us just what the place is of the engineer, the chemist, the biologist, and those other individuals who are concerned with water resources in the very much larger context of public economy and public scientific advancement.

Accordingly, I take great pleasure in opening the second half of our afternoon's meeting in which we shall hear from social scientists.

# Water Pollution Control and Its Challenge to Political Economic Research

DR. KARL BRANDT
**_Member, President's Council of Economic Advisers_**

The subject of this National Conference is certain aspects of the very wide range of closely interlocked problems concerning our Nation's intelligent utilization and development of one of its vitally needed natural resources: water, meaning chiefly fresh water, but also, to a much lesser extent, salt water in estuaries and at our beaches. Those aspects have to do with the deterioration of the quality of water in the course of nearly all of its uses by man, with the contingency of cumulative quality deterioration in a growing population and its expanding economy, with the damaging effects of such change in quality, and ways and means to diminish them by appropriate private and public management of better maintenance or improvement of water quality. It is my assignment to open the panel discussion of the challenge the problems of water pollution present to research in the social sciences.

Before I tackle my assignment I want to divest myself of any claim to authority as an expert on the subject. As an economist, I have not concentrated my studies on water resources or water pollution control as quite a few well-known economists have in recent years. All I can claim is that, as many fellow generalists, I have run into the economic impact of water rights, water use, water surplus, water shortage, and water costs throughout the years on both sides of the Atlantic and other parts of the world in economic policy studies on agriculture, forestry, and fisheries, or in general economic studies that had to consider transportation, power, industrial, and urban development, housing, recreation, public health, public budgeting and finance, or economic development in underdeveloped countries.

In practicing and directing land valuation and contributing to its theory I discovered more and more of the powerful influence and increasing importance of the demand and supply of water on public policies in an expanding economy, particularly in subhumid, semiarid, and arid climates. Participation in a Stanford interdisciplinary faculty team that contributed a report to President Truman's Water Resources Policy Commission in 1950 gave me a more intensive brush with the subject. Direction of a research project on benefit-cost analysis and water-pollution control on behalf of the U.S. Public Health Service[2] in 1957 and 1958 gave me some insight into specific details of economic analysis of water quality problems.

Since then, in the President's Council of Economic Advisers, I have had to deal with criteria for the feasibility and approval of water development projects by the Federal Government and other public policy aspects of water resources development. Conference with many leading scholars who are experts on the subject has given me a grasp of the extraordinary complexity of the social science aspects of our subject and a feeling of urgency of more penetrative research in depth by independent, critical, and creative minds in the various social science disciplines, particularly economics, economic geography, and law, and closer interdisciplinary cooperation.

The social scientists have always taken the cue for the problems they rate as having priority and therefore explore intensively from the contemporary pains of the society to which they belong. In that sense their disciplines belong to the applied sciences and their work can be evaluated by the contribution it makes to the actual current advancement of the pursuit of happiness and the welfare of their people.

It is a characteristic feature of the social dynamics of the American people as of today that, contrary to the gloomy assumptions of the thirties that resulted from the depression, the Nation feels assured of at least a continuation of the same vigorous growth and economic expansion it has experienced during the past two decades. Fairly reliable projections for the next decade and beyond show that the population will continue to grow at a lively rate, and all economic evidence points to the prospect of a continuing rise in productivity and real per capita income in terms of dollars of constant purchasing power, with more leisure and recreational activity as well as the prospect of a gradual shift of a larger proportion of the labor force to the output of services and intangibles.

It is inevitable that in the course of such powerful economic expansion and population growth the taming and civilizing of the raw natural environment, the harnessing, controlling, and better utilization of natural resources is one of the essential prerequisites of orderly sustainable progress in a well-governed and self-controlled society. In fact, the concept of what constitutes a resource never remains static, but shifts with the changing needs and wants as well as with the improving technology and the increasing capital of man-made resources in the developing society.

---

[2] Cf. R. J. Hammond, "Benefit-Cost Analysis and Water-Pollution Control," Miscellaneous Publication 13, Food Research Institute, Stanford University, Stanford, Calif., 1959.

Natural resources have no value or utility in themselves. They are exclusively functions of man's gradually more diversified and refined social needs and his abilities to satisfy them. They are basically, and become increasingly, opportunities to apply and allocate human intelligence, human resources, and man-made resources to them so that they begin to yield more and better services or materials or both in response to the evolving and changing needs of the society.

All this applies to the fullest extent to water in the American economy. It is not true that nature in the raw had an abundance of water as we have to define it today. This claim of the naturalists who think in terms of an ecological balance under the exclusion of man and his supposed damaging impact on a perfect nature is of no relevance whatsoever for social scientists and for a nation's practical necessities. Nature itself pollutes a lot of water, and so do many nature-admiring campers without realizing it.

There are neither material or physical conditions nor political or psychological reasons for getting frantic about supposed or asserted inevitability of an irreparable deterioration or a desperate shortage of natural resources resulting from a further growth of population. The longer I have studied economic problems of natural resources use the more I have become convinced and certain that so long as the sun radiation maintains life on our planet there need never be any serious scarcity of the means of the human race to satisfy its needs and its reasonably proportioned wants, provided the people make the effort and apply the commands of diligent husbandry as well as social discipline and commonsense to the conduct of their economic and social affairs.

I see no need for our country to repeat in dealing with water resources what was done in the thirties, amidst their policy-induced economic stagnation in the effort to advance the cause of soil conservation, conservation of forestry and petroleum resources. Then it became fashionable among social scientists to shift the emphasis in dealing with necessary economic adjustments into the area of moral philosophy. Soil erosion, soil depletion, clearing of forest land, poor management of forest resources—all these were declared to be crimes of greedy individualism against society—and besides the byproducts of the purely price-directed and profit-oriented market economy, and of farm tenancy, a supposedly wicked form of tenure and enterprise.

Simultaneously, it was asserted that the agricultural land resources had so irreparably been ruined for good as to make retreat from exports of farm products inevitable, and that soil conservation practices were extremely expensive and nonprofitable and, therefore, must be heavily subsidized by the Federal Government. Similarly, it was asserted that the evil of farm tenancy had to be cured by forcing it out of existence, and that the evil of forest depletion which is simultaneously ruining the Nation's water resources had to be cured chiefly by nationalizing the forest land and the management of the forests and of water resources. At the same time, while we were advised by the totally erroneous projections of the Nation's leading demographers that we had to count on a culmination of population growth within some 25 years and actual decline in numbers from 165 million people thereafter, we were urged to face the certain prospect of a disastrous decline and early exhaustion of our chief energy resource, oil, and had to use scantily whatever little was left of it.

I mention these meanderings of articulate social scientists and certain emotional tides that seem to run in longer political cycles in order to give some perspective to our subject. In the professions that are dedicated to the search for the truth it seems a moral obligation to recognize and admit such errors of the past in order to avoid repeating them in each generation of researchers.

Today we have long outgrown these temperamental excursions into socialism via the detour of moral indignation about capitalism and take a much more balanced and sophisticated view with reference to a politically conjured scare of an inevitable shortage of agricultural productive capacity, of a shortage of timber growth and forest products, and of petroleum. Indeed, in all of these uses of natural resources the problem of today is excess capacity of production and softness of sagging prices, although this need not hold forever.

In the area of these important resources, more and more sophisticated and mature social science research has assisted the Nation in adopting a more confident, understanding, and stable view. Public opinion takes it for granted that the market economy is capable of guaranteeing an adequately increasing yield from such resources as land and its fertility and oil, natural gas, and other minerals. Of course it is recognized that in all these cases the legal framework which lays down the rules of the game for the management of private and public enterprises and resource use has to be wisely amended and adjusted, not in the direction of socialization, but toward more effective allocation of complementary resources within the market economy.

In social science research concerning the use of natural resources it is widely accepted today that the problems of resource conservation, meaning the adoption of more efficient, less wasteful methods, are closely related to the gradual progress of economic development, the rising density of population, the progress toward more general and equal distribution of goods and services, and the increasing emphasis on safeguarding the future opportunities of the youth and social security for the aged and incapacitated people.

One understands today better that in the pioneer stages of development when the only scarce elements of production are manpower and capital, exclusively they must be used with utmost thrift and efficiency while this cannot possibly apply to the ubiquitous bonanza of nature which in its raw state is more of a nuisance and has next to no value. Intensive use and conservation begins to make sense only when limitation of opportunities looms up, but then it becomes not a matter of esthetics or moral preference of individuals or groups, but of ironclad economic necessity.

This applies particularly to the concept of water resources and their intelligent use. However, there is one important exception that applies even to the totally undeveloped economy in any part of the world; namely, the protection of the sources of drinking water for man and farm animals from contamination or the effective decontamination or disinfection of such supply. As is the case with the other resources, the concept of water as a resource itself, the need for its use in more and more forms, and the leeway for intensifying and making such use more economical, all this depends on and changes with the progress in the sciences and in the technology in use in a country.

The enormous acceleration of the pace of improvement in scientific knowledge in the biological sciences and in technical innovation of the last few decades has expanded their demand for water, particularly in its agricultural and industrial use. However, with it have also expanded the opportunities and technical means for capturing and storing fugitive supplies, and for making better, more intensive, and economical use of water, including particularly its reuse which in some instances of nonconsumptive uses goes up to the point of total consumption of a given quantity. More and better means are at our disposal for making water available at preferred locations, for coordinating complementary uses, for upgrading its quality, and for discharging polluted effluents with or without purification treatment harmlessly into aquifers, the underground, the ocean, or the atmosphere. While there remains a great deal to be done and to be invented, we may be confident that this can be achieved at a sufficient rate.

The social scientists dealing with water-quality problems have the cumbersome, somewhat pedestrian task of familiarizing themselves properly with the technical aspects of water in all its actual and potential uses in this country and abroad, and of keeping themselves somehow informed about the advancing frontier in water-use technology, particularly any methods leading to more thrift in water use and to lower costs in water-quality conservation.

In all this the essential aspects in the use of water are those of capital requirements and costs. Particularly in the area of water-quality control and improvement a great deal is going on in technology and cost reduction, while in raw materials processing and chemical industries the recovery of waste materials is also proceeding toward improvement in discharged effluents.

It would seem futile if some scientists were to try to keep abreast of the changes primarily by following the very extensive biological and technological literature. To keep themselves abreast of what is going on requires, of primarily economists and lawyers, to keep in close touch with hydrological, industrial, sanitary engineers, industrial consultants, representatives of industrial organizations concerned with water problems, and public administrators responsible for water supplies and pollution control.

Fortunately, such contacts are easily established in nearly all States, particularly through the good offices of the U.S. Public Health Service. This live contact with the experts is even more necessary in order to be aware of the policies adopted by private enterprises and agricultural, industrial, or public utility organizations, and of the public policies administered and enforced by local, State, and Federal Governmental agencies in specific areas. Without such personal and institutional flow of information in support of what can be traced through documents, laws, and ordinances, the researcher is prone to be unaware of the remarkable progress that has been achieved since the war in many of the crucial areas in this country and of the exchange of experience and knowledge between, e.g., the United States and the OEEC countries, or the United States and New Zealand.[3]

What, then, are the contributions by the social sciences which would at this juncture assist the Nation's progress most? My answer is not based on any systematic survey, but on impressions gleaned from reading a number of books, articles, congressional hearing reports, and on discussion with a few researchers in this field.

The frame of reference for the development of water resources and pollution abatement in the coming years must inevitably consist of the expectable situation in our national economy. While it has made remarkable progress in the 14 years since the end of World War II, it is also a solid fact that during the last two years the era of a monopoly of supply of the American export industries and a monopoly as a source of financial aid and investment capital has come to an end. It lasted actually from 1938 till 1958, or fully 20 years. That it has come to an end is the inevitable byproduct of the success of our gigantic effort to rebuild the bomb-scarred and badly shaken economy of Western Europe and Japan and our further effort to start industrialization in many newly independent nations, as well as our building up of the U.N.

---

[3] Cf. OEEC, Organization for European Economic Cooperation, European Productivity Agency of the, "Air and Water Pollution, the Position in Europe and in the United States," Paris, February 1957.

and its independent agencies, foremost the World Bank and the International Monetary Fund.

This reconstruction of the economy of the free world has found its crowning achievement in the restoration of hard convertible currencies in England, on the European Continent, and in Japan. With it has been restored a hard international competition on the basis of quality of products and price. This requires a sharp discipline as to the containment of cost-push as well as demand-pull inflation and a severe discipline in capital formation and investment.

In view of the fact that the development of water resources involves invariably the investment of large amounts of capital, mostly for very long periods, irrespective whether the source is private or public, and since the service of this capital enters the national cost account, it is now more mandatory than before that an optimum use be made of such capital. This does not imply that the development of our water resources be geared exclusively to a minimum cost of industrial production and that all intangible benefits or all future benefits should be sacrificed. Far from it. However, from the standpoint of continued success of our agriculture and industries in competition in the world market, the balance of payments, the integrity of the currency, effective control over the Federal and State budgets, and, therefore, in the interest of the improvement in the real income of the people, it is imperative that prudent husbandry prevail in the use of other resources for the development of water resources. This must also apply to water pollution abatement.

The public in general, the legislators, and the public administrators ought to receive from economists and associated social scientists the best information and guidance possible on the economics of the solutions offered by the engineers and the proposals made by pressure groups and interested parties. They ought to bring into focus the existing alternatives as to technical solutions, the costs and losses incurred by and the benefits accruing to all parties in the case of execution of specific projects or the nonexecution of such projects, as well as the differences resulting from partial execution and delay for the remainder.

Futhermore, it is most desirable that economists lay bare the results of changed prices charged for the use of water in the allocation of such resource use to various users. Their greatest contribution may be expected by demonstrating the extraordinary variety of economic arrangements and adjustments that are possible for solving problems arising from increased demand for water in the expanding economy.

In this whole area, I feel that we are on the threshold of great progress, because in various places in this country, notably some universities and research organizations, a good deal of work has been launched and some products are beginning to appear. I consider the Rand

Corp. research study by Hirshleifer, DeHaven, and Milliman entitled "Water Supply, Economics, Technology, and Policy," that just came off the University of Chicago Press and contains the results of several years of intensive research, as a most timely and far-reaching piece of work that shows what can be done. It continues the authors' own earlier studies and utilizes work done by Eckstein, Krutilla, Renshaw, Haver, Cyriacy-Wantrup, Tolley, and others, and arrives at most salutary recommendation as to policy.

At present it appears to me the risk is greater that more capital investment is forced into publicly financed water resource development than is compatible with over-all allocation of scarce resources according to principles of efficiency than the risk that the development of water resources is lagging behind the needs. If this be the case, such overinvestment by premature development of basically sound projects, or by political yielding to demands for public financing of financially and economically unfeasible projects, cannot avoid weakening the comparative advantage of American agriculture and industries. This risk is particularly real, due to a variety of circumstances which have a bearing on the investment in water-development projects, including those for water pollution abatement.

I name only a few. A large part of the projecting is done by engineers, who owing to their limited area of responsibility, apply high standards of safety and think in physical terms of rigid minimum "requirements" of quantity and quality of water. Frequently they think of total or ultimate development of water resources. They and very articulate public groups that support them have concepts of water being a unique resource and material which must be accorded priority above all others, and they have usually a range of priorities among classes of users that gives household use top rank and agricultural irrigation second rank.

Public financing with tax-exempt bonds is often approved by majorities of voters who either consider themselves as exempt from the immediate impact of the costs involved in higher real estate taxes or who speculate on exceptionally high benefits for themselves as the result of high increase in real estate values. Many of the voters, and particularly many of the local and State government officials, have become accustomed to the expectation that in the long run such indebtedness will lose most of the weight as a budget item because, with terms of many decades, creeping inflation will take care of most of it.

As soon as Federal Government financing enters the picture other considerations impede a policy of optimum efficiency of national resource allocations. While benefits are mostly accruing locally or within a State the costs are, even when reimbursable, distributed over the taxpayers of 50 States. Indeed, since Federal taxes are collected within States, taxpayers have an incentive to get as much as possible of the revenues "repatriated" to their State or municipality in the form of Federal finance for projects. The incentive is still greater in economically weak States because there Federal financing may mean the transfer of Federal revenues far in excess of what originated in the State.

In its historical tradition of giving next to defense including navigation priority to the development of agriculture, the Congress has granted in its legislation that project costs for flood control and navigation are nonreimbursable, and that costs involved in irrigation are reimbursable free of interest, and over periods which may actually reach 60, 70, or more years. In the approval of water-development projects for partial or total Federal financing by the executive branch of the Federal Government the rules for judging the economic feasibility require a ratio of benefits to costs in excess of unity and for a choice between projects preference for the one with the higher ratio. Not only does this invite overestimation of benefits and underestimation of costs, but it provides no sensible criterion for a comparison of many projects as to their contribution to the growth of the social product.

It may be questioned to what extent all this is pertinent to our subject of water pollution control, since the benefit-cost analysis has not been compulsory in its application to water pollution control projects, but has only been tentatively considered as a potential approach to economic analysis of projects and to appraisal of the value of pollution abatement. However, the weakness of the procedures of evaluation of economic feasibility and justification applied to water-development projects in general is nevertheless closely interlinked with water pollution control, because water pollution is an essential feature of nearly all legitimate use of water, and because one cannot separate the damaging effects of any sort of contamination or lowering of quality from such phenomena as volume and velocity of flow; i.e., degree of dilution, seasonal variation of flow, stagnation, temperature changes in reservoirs or navigable canals, recharging underground supplies with reclaimed sewage water, and many others.

One of the obvious discrepancies in our national policies of resources use and development lies in the continuation of Federal budget expenditures annually in storage, transportation, and losses in handling the excess stocks of farm commodities. It is assumed that in the West over 90 percent of the water is withdrawn by irrigators, and it is also assumed that on the national average less than 40, but in the West often only 20 percent, of the irrigation water is salvaged for replenishing the underground water, and its quality is seriously reduced by a considerably higher content of dissolved minerals. Yet much of the irrigation water is supplied at prices considerably below cost.

The least problematical part of pollution control concerns municipal sewage as distinguished from industrial and particularly chemical plant discharges. In the case of municipal sewage primary treatment is relatively easily achieved, involves relatively moderate total capital requirements and operating costs, and even secondary treatment, while substantially more expensive, does not seem to lead into the range of difficult economic or administrative questions.

The far more important problem lies in industrial use of water, mostly for cooling, but increasingly for the discharge of industrial wastes, particulary dissolved organic chemicals into municipal sewers, creeks, rivers, and estuaries. In recent years the discharge of waste materials from atomic fission has added further technical as well as social and economic complications. The resulting changes range from unsightliness of riverbanks such as ugly foam or discolored water, bad odors, prohibition of swimming and pleasure boating, and fish kill to high costs of water treatment for downstream industries, and decline in residential or farm values of real estate adjacent to the banks of the river.

Yet, here as elsewhere in resource development, the country needs advice based on careful evaluation of the consequences of such water-quality decline for certain directly affected parties as well as the public and the costs of alternative courses of remedial action and the distribution of such costs. While it is technically possible to restore river and canal water to its virgin quality of nature prior to industrialization or even better, including the restoration of all aquatic biology, it all involves severe costs and complex chain reactions in our economy. Hence social science research should explore and demonstrate the alternative courses for achieving a reasonable compromise which permits an aggregate benefit to the community of people affected. To do this involves ultimately quite a few value judgments. Again, what should be proved is the social cost of achieving certain intangible benefits to whom they would actually accrue, and who would share the costs, directly and indirectly.

It should be demonstrated particularly, that the costs involved for varying degrees of improvement in the quality of aquifers are ultimately entering into the account of the American economy and thereby inevitably affect all the people. Costs of water pollution abatement can be deflected or charged to certain individuals, corporations, or other forms of enterprise. However, as in the case of taxes and levies, the actual burden of such costs is shifted to a broader number of people if not the public in general.

Reliable and accurate knowledge about costs and their ultimate bearers should not and will not prevent the people and their representative government from making progress in water pollution abatement. On the contrary, the better the public understands the complex and interlocked issues of intelligent water uses and the necessary adjustments, the better become the prospects for arriving at sensible solutions by voluntary cooperation and consent rather than coercion and bureaucratic rule of more and more centralized power. If the citizens of a State understand fully what it means in terms of costs to enterprises and to the public if perfectionism prevails as, for example, quality criteria for industrial effluents into rivers are lifted to unrealistic levels, or one should require secondary treatment for municipal sewage disposal into the ocean, then we may expect to arrive at reasonable compromise.

Such compromise could lie in gradualness in the raising of requirements, in adoption of reasonable standards and a broader participation in shouldering the costs. While it may be deplorable that some fish are killed in a river or canal which actually served primarily as a carrier of industrial waste it may yet be the case that this use of that particular current of water in a strictly industrial area may prove to be the highest marginal productivity attainable that far outweighs any potential value of the commercial or the sport value of the fish.

With all the remarkable progress we have made in recent decades in public understanding of the issues involved in resource development. and water and air pollution, there remains an enormous task to be performed in general economic education. Such education presupposes that research in the social sciences provides the knowledge on the local, State, and national issues involved in water pollution.

In tackling public policy issues of water pollution abatement the schools of thought which are critical of any market approach to the optimal allocation of water resources to different users and uses tend to see the avenue toward improvement of water quality in transfer of all responsibility and power of allocation to central administrative agencies within a State, if not an entire river basin, preferably under Federal legislation. They frequently ignore the profound change in land and water law that is required, and even more so the extraordinary amounts of capital involved in compensation for the transfer of such title under eminent domain and the aggrandizement of the already unwieldy size of the bureaucracy involved in such change. Bigness in public administration, the degree of centralization, depersonalization and diffusion of decisionmaking are inevitably causes of inefficiency, and thereby rising social costs.

In conclusion, I anticipate the need of a considerable allocation of research resources in economics and law, to problems arising from the necessity to abate water pollution. However, such research must consider problems of private and public water quality management as an integral part of problems of efficient use of water in all forms, and of other resources. The greatest challenge lies in the opportunity of contributing to a better understanding of alternative arrangements by which the desired ends of optimum pollution abatement can be attained with a minimum of costs and a minimum of distortion of our economic system.

# DISCUSSION

Dr. Gilbert F. White
***Professor of Geography, University of Chicago***

Many of the problems upon which Dr. Brandt has touched and with which I shall deal have been suggested by Messrs. Pearson, Zapp, Leake, Eliassen, and Hazen. To speak of there being economic limits to a treatment process implies knowledge of the social benefits and costs. To speak of an industry or a community making a choice among different ways of dealing with water pollution is to imply that there is knowledge of the different solutions and of methods of assessing them. It also assumes that there are public agencies and policies capable of considering and making the choice. To speak of improved communication and of enlightened public opinion is to imply knowledge of attitudes and attitude formation. Much of this knowledge still is lacking.

It would be comforting to believe that the people of the United States certainly will exercise sufficient husbandry, discipline, and commonsense in their economic and social affairs to prevent any serious scarcity of water or any inefficient deterioration of water quality in the years immediately ahead. That position seems sanguine in view of the physical limits of available water, the widening gap between technical knowledge and its application on the streams, the shortage of analytical tools for determining efficiency, and the prevailing ignorance as to ways in which water quality now is managed.

Clearly, there is enough water in the country as a whole to meet prospective needs and still maintain high standards of water quality if proper management is exercised, especially in certain areas. It seems equally clear that the Nation has been slipping behind in its efforts to curb the mounting pollution load. The very holding of this Conference testifies to deep uncertainty as to effective methods to deal with the resulting set of problems. Here, as with some other aspects of water management, technical skill apparently is running ahead of practical application: the rate of advance in moving, storing, treating, and appraising water, even recognizing that progress in waste treatment has been conspicuously slow, is greater than the rate at which this knowledge is being put to use in cities and industry.

The growing gap between practice and technical knowledge is at the very heart of the problem of dealing with water pollution. It is made especially complex by the difficulty of applying the market mechanism to pollution-abatement measures: unlike municipal water use or irrigation water withdrawal, there is no ready means of setting values by the interplay of market forces. Thus far, no city has found a way to induce its citizens to dispose of their garbage and trash through the market, just as no owner of small forest properties has perfected the control of forest fires without relying upon public assistance and organization.

Although the prevailing evaluation and pricing of water is a substantial obstacle to efficient water management, and although better pricing would enhance water quality in most areas, any move toward a more rational system runs head on to highly inflexible public attitudes and institutions. Ironclad economic necessity has not yet cracked some sacred images. If this is the case with evaluating and pricing water for direct agricultural and manufacturing use, how much more remote is the likelihood of employing a market mechanism for setting water quality for uses involving esthetic and ethical considerations?

When we try to assess the social desirability of reducing or curbing pollution to various limits, and when we try to appraise the merits and demerits of alternative ways of holding those limits, we are handicapped by ignorance in several sectors. We do not understand the circumstances in which private and public managers make decisions as to pollution abatement; we lack incisive methods of appraising alternative solutions; and we are largely in the dark as to the effectiveness of various government mechanisms for coordinating water development and pollution regulatory activities so that intelligent choice may be made among possible solutions.

### Elements in Decisions

Although much effort has been given to identifying sources of pollution and to estimating dilution and treatment needs to achieve various levels of water quality, relatively little is known as to the social environment in which decisions on corrective measures are taken by legislators, city managers, or corporation executives. Without attempting to outline all of the directions in which research seems essential to developing an adequate understanding of the circumstances of such decisions, a few examples can be offered.

The elasticity of demand for water for industrial and recreational uses is not well established. This is fundamental to any economic analysis.

Public attitudes towards water quality, as witness New York City's water supply, may determine an entire public program, but are discerned only dimly at the ballot box.

The way in which industrial managers estimate water quality, water needs, and technological change in planning new waste-treatment works is not understood. We have no adequate explanation of the role of waste treatment in the location of new industry, although we are rather confident that it is much more important than water supply. Nor do we know in any sophisticated degree the impact of pollution on land values.

Perhaps the greatest deficiency is in knowledge of the effect of various social constraints and guides in pollution abatement activity. Notwithstanding predictions in the Advisory Committee report of 1939 [1] that Federal exercise of regulatory authority would lead to transfer of all enforcement activity to the Federal Government from the States, we do not know what the legislation of 1948 and 1956 has in fact done to the decisions made thereafter by city officials and manufacturers. How significant is public opinion by comparison with financing and regulation? This is still largely speculative, and can be answered only by careful investigation of municipal and industrial situations.

## Methods of Appraising Alternative Solutions

Obviously, many waste-treatment programs now are undertaken without a systematic attempt to calculate the full social returns and costs of the enterprise. The danger of overinvestment in pollution abatement is real. But we must recognize that the available methods for discounting these streams of income and costs are at best rough. While current benefit-costs methods have been shown to have serious weaknesses, the administrator has few sharper tools to use in trying to find optimum solutions among alternative plans. Here is a pressing need: to refine and sharpen the analytical tools so as to take account of all factors relevant to public choice.

## Machinery for Choice

As with other aspects of water development, there is a severe lack of administrative machinery which would provide for a reasonable public choice among alternatives. Rarely is the full range of alternatives considered. The range of possible adjustments to threatened impairment of water quality is great for most situations, including readjustments in land use, different degrees of treatment, different degrees of dilution, and a wide array of regulatory and financial measures.

It is rarely the case that there is a simple choice between an engineering project and pollution. Having the analytical tools is important and may well be the greatest research challenge, but there must be hands to wield them. We have only begun to critically examine the kinds of administrative machinery that can serve to apply tools and knowledge of local conditions to the design of basin programs and to their execution, particularly by non-Federal agencies. Recent research has directed some attention to interstate agencies, but the strength and weakness of other state and Federal mechanisms has not been fully explored.

---

[1] United States, 76th Cong., 1st sess., "Water Pollution in the United States," H. Doc. 155 (1939), p. 84.

Nothing has been said about the disciplines from which answers to these and other problems may be drawn. They include anthropology, economics, geography, law, political science, and sociology. More important than the discipline is recognition that research leading to understanding of each of these aspects of pollution abatement is essential to formation of balanced public policy. Without it the tendency will be to rely upon either traditional engineering or traditional regulatory devices. The Federal experience with curbing flood losses since 1936 should be a sobering warning that reliance on engineering alone may only exacerbate the problem.

Finding the combination of private and public measures suited to the national aims and resources will claim the best thought of students of attitude formation, geographic location, economic optimization, and political process. Research along these lines properly should go arm in arm with the training of personnel and with research on the physical effects and treatment of water pollution.

## Panel IV

### General Discussion

**Dr. CANNAN.** This question is addressed to me by Prof. Theodore Jaffe, Auburn University: ***"If there are to be only a few large graduate schools to be inspired or directed to graduate study in sanitary engineering, how are the small schools to attract and hold a faculty?"***

My first reaction is that this situation as in most things it is well to begin at the more promising beginning. If we can establish a few effective models of what is needed, then we may hope that they will be imitated by other smaller schools until the need is met.

The proposal to encourage the strong schools is not a proposal to suppress the others. On the other hand, the latter should not be encouraged to continue to attempt that which they cannot do adequately.

Not every university feels the need for a medical school. Still students medically oriented do find their way into medical schools.

**Dr. FAIR.** The next question is addressed to Dr. Rohlich.

**Dr. ROHLICH.** This question is from Dr. W. W. Hodge, Koppers Company, Inc., and Mellon Institute: ***"Are the positions as heads of State public health departments usually given to men with M.D. or sanitary engineering degrees? And is it better to get an M.D. and then a D.P.H. or a sanitary engineering Ph. D. and then a D.P.H., or Doctor of Public Health?"***

I would think that the heads of the State public health departments are, almost to a man, M.D.'s. Somebody correct me if I am wrong in that.

Is it better to get an M.D. and then a doctor of public health or a sanitary engineering Ph. D. and then a doctor of public health?

This will not endear me to my friends in public health. But I think it would be preferable for a person who is so inclined to obtain his medical doctor's degree and then go on into the field of public health, and similarly I personally would advise the sanitary engineer to first obtain the sanitary engineering Ph. D. and then go on to a doctor of public health. I am not sure that answers your question, but that is my feeling.

**Dr. FAIR.** There are two questions for Dr. Eliassen which Dr. Geyer has kindly consented to answer.

**Dr. GEYER.** Leslie M. Dalcher, Fairbanks, Morse and Company, Chicago, has this question: ***"Has recent research produced any promising new methods of treating wastes from individual households?"***

The quick and simple answer to that is no, but it might justify a little comment. There have been continual improvements of the old methods, and one of the recent good studies was financed by the Federal Housing Administration. This work indicated that disposal fields with the laterals operated in series rather than in parallel seem to work better. The old accepted systems are not bad except they are poorly understood, poorly installed and poorly operated. As a result of this, most individual household systems fail in 5 or 10 years after they are put in. People who have had control of these individual systems have begun to review their activities and wonder whether what they are trying to do is really worthwhile.

Baltimore County, for example, spends a great deal of effort in trying to control the installation of individual household systems. They estimate they have 25,000 of them in failure and they are wondering whether what they are getting is worth the effort that is going into it. What has happened seems to support the contention that the best solution for individual households is to put the sewage in a public sewer and let the community take care of the problem.

I know there are some of the manufacturers of home appliances who have become interested in this problem. They would like to find ways that they could treat the waste water and return it to the water supply, solving at a single blow both the water supply problem and the water disposal problem, but I hardly think the enormous difficulty of doing this needs to be pointed out.

**Dr. FAIR.** Dr. E. R. Baumann of Iowa State wishes to make a statement.

**Dr. BAUMANN.** I made this comment out about an hour ago after Dr. Cannan's paper. It could equally be directed to the whole panel, because the thought occurred to me as to whether we are not putting the cart before the horse.

I think we all recognize that we have a tremendous backlog of work to do to clean up our problem of water pollution. To do this, we are going to need a tremendous amount of research conducted and we are going to have to train a large number of sanitary engineers to do the research and to build the steel and the concrete necessary to put this research into effect.

However, we are still operating in a capitalistic system and men are still motivated to enter a profession at least partially due to potential economic reward. Dr. Cannan mentioned the medical profession. I am a professor acquainted with many students. Most of those who go into the medical profession commonly expect to earn from $20,000 per year upward in the practice of medicine. Hence, there is no shortage at the present time of students desiring to enter the medical profession.

Median income of sanitary engineers, however, and at least 50 percent of them are employed by government agencies, is still less than $9,000 per year. This is the lowest median salary of any engineering branch, any of the major engineering branches.

How can we motivate students to enter graduate programs in sanitary engineering when they are required to go further in education? Some 35 to 40 percent of our men in sanitary engineering now have master's degrees. How can we motivate them to go in when the financial rewards just aren't there at the present time?

In Iowa, our State Health Commissioner is still limited to a salary of $9,000 a year, our State Sanitary Engineer to a salary of less than $11,500 per year. Our 20-year men in the State Health Department in Iowa still earn less than $9,500. Would you, if you were a student, enter this field for financial rewards? It is obvious that we must strengthen our present school potential by increasing financial rewards in our support of research programs. Our present research programs and our present programs help to finance a student's education, but do not provide the financial rewards after his formal education is completed.

Being in education, I recognize that we can't all be chiefs, we still need some Indians, and it is the Indians that we are trying to educate that are getting these median salaries which are not attractive.

I remember 15 years ago when I entered the field, one of the things I was anxious to do was to express the young man's viewpoint. I stand here today at the end of 15 years, able to express the young man's viewpoint, and I am no longer one of the young men. As I look around the room here today, I would recognize that these men, the men who are getting in this lower salary group are not represented here, because I would expect that 90 percent of the men in this room today are in the 10 percentile of earnings of sanitary engineers.

**Dr. FAIR.** Undoubtedly this is a very important question, but I can't help thinking, coming from a missionary family, that there are other inducements as well to enter a profession, there is such a thing as a calling. So far as the medical profession is concerned, it is having just as hard sledding today in attracting qualified people to itself as is the sanitary engineering profession and even chemistry. The big call apparently at the present time is in physics. The competition for the best minds of the country seems to be in physics and in law, and all of the others are having a rather difficult time just now.

**Dr. BRANDT.** The question by G. E. Condo, Chairman, National Clean Waters Commission, Izaak Walton League: ***"Research to develop a market approach to waste disposal is admirable, but so far it has been impossible to definitely assign dollar values to many of the real benefits of clean water. Don't you believe public policy requires as high a degree of waste treatment as possible during the interim period of social research?"***

In discussing the question of treatment of sewage of cities, I do not consider it as so essential to have an enormous amount of market research into water. In many communities with a reasonably decent government where the people complain about nuisances connected with discharge of untreated sewage, such as bad odors, unsightliness, or the general filthy condition of the water, which makes it unusable for recreational or other purposes, I see no need for putting a dollar value on such effects.

I have the confidence in the good common sense of our people in their communities that when they want to abolish some public nuisance, when they are agreed that it is one, they ask the two questions: (1) What does it cost to remedy the situation perhaps by alternative methods? (2) Can they afford to do it? In the majority of cases that I know, the local community can afford to establish primary sewage treatment because the costs are not enormous. Therefore, why should one go through the trouble of using a formula that puts a dollar value on largely intangible benefits or on the ratio of costs and such artificially priced benefits. This can only sidetrack the initiative in controlling pollution.

Naturally, if we emancipate ourselves from the hard realities of the political economy ignoring the scarcity of our manmade resources we may envisage as high a degree of waste treatment as is technically possible, irrespective of costs involved. But who would really be so irresponsible?

It is my impression, however, that municipal sewage treatment is the least complex one of all water quality control problems. The really tricky problems concern industrial waste being discharged into various aquifers. There you arrive at closely intertwined sets of intricate problems of multiple use, reuse, regularity of flow, and many others. You may have to weigh here, let us say, a factory that could employ 5,000 people, but would simultaneously either pollute a river or a canal or would have to bear considerable additional costs for discharging only treated effluents or for discharging its effluents harmlessly untreated into the ocean. There arise very difficult socioeconomic questions. There a study by economists of all alternative courses of remedial action that are open and the presentation to the electorate of their findings and recommendations, and the real economic issues that are involved in their decisions could do a great deal of good. To weigh so and so much local employment and income of people on the one hand, and strict enforcement of very high quality requirements for effluents on the other, is an area of decision-making where I really count on economic research.

One begs the most interesting questions by saying: "We want a maximum of water treatment." Is it a maximum under all circumstances irrespective of such social costs as less employment? Economists are primarily involved when it comes to the question of costs, and alternative methods for lowering costs. Economists want to determine how much the total costs are, who or which group will ultimately carry the burden of such public charges.

In my paper you will find some reference to this shifting of costs, of financing water pollution control measures to Federal and State governmental levels.

**Dr. WHITE.** This question comes from Dr. Fair, and I want to say that the nature of my response does not spring from the fact that I happen to be standing between Dr. Fair and Dr. Brandt. You will understand my qualification.

***"What members (in terms of professional competency) would you recruit to an ideal group concerned with water resources within the framework of the national economy?"***

I will answer that by saying I think I would recruit the kind of group which was recruited for the Water Resources Seminar at Harvard or the new program in water resources study at Stanford with a couple of exceptions. In each case they have political scientists, economists, hydrologists, and engineers involved, trying to look at the problem in one case in terms of an idealized basin, in another case within the broad realm of public policy affecting water. The contributions of these groups, I think, are evident. For example, it is apparent that there are always some economic considerations, but, as Dr. Brandt has suggested, there may be situations in which the benefit-cost kind of analysis simply doesn't apply, and it is a matter of political judgment as to where it is appropriate and where it may be either inappropriate or actually a disservice. I would indicate two other professions that I think have something very important to contribute to such investigations, whether it is under the auspices of an institution or a Federal agency.

One is the geographer who brings information and insight into the way in which activities are distributed spatially. To give an example, we talk a great deal about the effect of water supply on industrial location, but the fact is that we know very little about it and the actual impacts of water supply availability on location and probable shifts in location as a result of changes in water supply.

The other is the anthropologist. When I see the defeats of some people on fluoridation votes or when I see the kind of treatment that the New York City board of water consultants received on their Hudson River proposal I feel that an essential part of dealing with public policy in programs affecting water is to look into public attitudes, their formation, and their relationship to social organization and structure. I am not being facetious when I suggest that beliefs concerning holy baptism and the sanctity of water may have more than passing significance to the way a vote goes on a bond issue in California, and that if you are going to be practical about dealing with water supplies, you have to understand the kinds of attitudes people have toward water and the ways in which these attitudes may be shifted. You can have front-page stories on every newspaper every day of the year, but if these stories are not related to the basic beliefs and patterns of association and prejudice of people to whom they are directed, they may have little or no effect. So I would say we need a number of disciplines, including a couple which Stanford and Harvard have not yet included.

**Dr. BRANDT.** This is a question from Dr. Heukelekian, Rutgers University: ***"Do you apply the same criterion of value judgment and national cost accounting to the private sector of the economy as you do the public sector?"***

Certain values and judgments based on them are ultimately underlying all discussions about affairs in the political economy in which we live, where the people govern themselves and ultimately decide at the ballot box what they want. Values are anchored deep in the hearts and souls of the people. I feel that in dealing with policy matters a social scientist has no right whatsoever to set up his own value judgments which differ from those on which the society stands. Such values are e.g., freedom, or that barest minimum of interference by others in our private life which is unavoidable for the national welfare. They too must be duly considered in water pollution studies.

We want an intelligent and informed electorate that decides on the policies of water pollution control and on the choice of costs that are ultimately carried by the taxpayer. Well-informed people who see all the sides of it, who see the alternatives, who see the costs shall make up their minds. Coming from a State in which the referendum is used to the extreme, I can say that by and large I am always pleased by the soundness of the judgments the people pass at the ballot box.

However, in this water pollution area, it is my impression that much too little knowledge exists about all the economic and social issues that are involved in decisions. But once the people are well informed they will use their own value judgments, which can neither be manufactured nor be set by social scientists. Social scientists and economists ought to be on tap, not on top.

**Dr. CANNAN.** Dr. P. R. Dugan, Syracuse University Research Corporation, asks this question: "***Most panel members have indicated that research is needed which embraces the overlapping of the several disciplines: engineering, biology, chemistry, medicine, law, et cetera. Sanitary engineering appears to be but one aspect of water pollution control. Why do you advocate training future investigators in sanitary engineering rather than the broader disciplines of public health science or water control science, for example, which would consider toxicological problems and so forth. The solution of water pollution problems will embrace several disciplines such as engineering, biology, chemistry, law, and so forth, no combination of which can completely be satisfied in a given academic curriculum.***"

I agree that the disciplines contributing to water management continue to expand beyond those traditionally associated with sanitary engineering.

My position is that sanitary engineers, by reason of training, skills, and an orientation toward practical problems in the field are best qualified to identify research needs and to mobilize the help of specialists.

Many problems are first identified in the field but must be fed back to remote laboratories for their solution. Others are recognized as significant in the field only because of new discoveries in the laboratory. Progress is a two way traffic.

You ask if the title sanitary engineer is still appropriate. A number of others are being proposed. I doubt if we are ready to dissociate the field from engineering. The need is for the engineer to frame his problems to chemists, toxicologists, biologists, sociologists, and the like so as to stimulate their interest and cooperation.

**Dr. ROHLICH.** This is a question from Harry S. Bingham of Clarkson College of Technology in New York: "***The importance of graduate study has been stressed in your remarks, and I would therefore question whether you mean to imply that there is no foreseeable problem in interesting the undergraduate in a career in sanitary engineering? Due to the unbalanced emphasis on***

***some of the physical sciences at many of our schools of civil engineering particularly, I have found that an overwhelming majority of the undergraduates make up their minds as to future employment and interest before the major sanitary engineering course or courses have been presented to them. Would you care to comment?"***

I certainly must agree with Mr. Bingham that there is, of course, a long lapse in undergraduate training before students get any courses that interest them in going forth in sanitary engineering. I did not mean to imply that there is no foreseeable problem in interesting undergraduate students in a career in sanitary engineering. I think there is a real problem.

Last evening I had a talk with Dr. Weinberger of Case, who had some very cogent ideas and actually had put into practice a program of interesting undergraduate students in a career in sanitary engineering. Mr. Chairman, I wonder if it would be in order to ask Dr. Weinberger if he would be willing to repeat some of the remarks he made to me.

**Dr. WEINBERGER.** I shall be very happy to do so. Of course, I have been very pleased with this afternoon's meeting. The introduction of the social scientist viewpoint has been really stimulating.

On the matter of getting students into sanitary engineering, many of us have felt there is a need for some sort of missionary activity along this line, and we have to do something about it.

Mr. Camp mentioned there has been a shortage for many years, and although he indicated there was much activity, I, for one, would have to question whether there really has been activity or just wishful thinking.

A number of years ago, we became concerned with the fact that with the shortage and need for sanitary engineers, that there is a shortage of students and qualified applicants, not only at our school, but nationwide. An important finding was that many of the students would have tremendous opportunity but didn't even know about the scope of the field. As a matter of fact, in talking to a local chapter of the ASCE, I find that many of the people practicing in the field do not, themselves, have a knowledge of the breadth of sanitary engineering activities.

Many of the things that we talked about this afternoon would be entirely new to them.

I have proposed that some of us interested in this field, some of the people who have this overall view of the subject, actually go out and present our story to students and faculty in the undergraduate schools. As was mentioned by Dr. Cannan, the medical schools have already developed the idea of the undergraduate school where boys go for premedicine and then go on to medical school. We have to develop a similar chain.

I would, therefore, propose that we actually take the time and visit undergraduate schools that do not have sanitary engineering professors or sanitary engineering graduate schools and talk to the students and faculty and present to them our story. I would also urge that we visit other departments, including chemical engineering, chemistry, and the life sciences and acquaint these people with our field. We overlook the fact that these people, who potentially can make significant technical contributions, aren't even aware of the problems that exist in our field. We assume they do. They must be told of the challenges.

One further point, I do not think it is necessary that we make sanitary engineers out of everyone interested in the field of sanitary engineering. There is a shortage of manpower, but some of this manpower could and should be trained and educated as chemists, biologists, or social scientists. They don't have to end up being sanitary engineers. We do have to present our problems to them if we want them to accept the challenge and work on their solution.

It is hard to believe that many of the people here today, with their knowledge of the field and their dedication, would be unable to attract more people into the field, if they actively worked on it.

**Dr. CANNAN.** This brings me to a closely related question. Dr. Heukelekian of Rutgers University asks: ***"How can men trained in basic disciplines contributing information to water pollution control be induced to be interested in research, training, and teaching in this profession?"***

There is no simple answer. We have heard that we must propagate the gospel to youth in its formative years. Unfortunately, there is currently an ostentatious solicitation of youth by all branches of technology. I would leave it to the political scientists here today to consider whether this free competition, this mad scramble, for scientific manpower in the face of limited supply is the best way to meet the national need.

There is a feeling among us that we are at a disadvantage because sanitation is not a field with a natural appeal to youth. Nor are many other human endeavors that find their following. My thesis is that if a spirit of excitement, of intellectual and spiritual satisfaction, pervades the exposition of the substance of a profession, men of good quality will be recruited to fill the ranks. The contagion is spread by the teacher rather than by circus tours of high schools with films, brochures and exhortation.

**Dr. FAIR.** Dr. White, do you want to comment on that?

**Dr. WHITE.** In respect to what Dr. Cannan has just said, I have been impressed with the fact that in a number of fields which one might consider would have great challenge today, take the field of municipal and metropolitan area planning, there is a somewhat similar situation to that described. I feel quite clear myself from being involved in college administration that getting information to prospective students may be helpful, but probably the choice is in relation to much less accessible kinds of experiences of the students. What do they consider to be a challenge, what do they consider to be a useful and exciting part of the life into which they are going? I don't believe we know much about how we recruit first-rate people for some of the services. There is now a national commission that is trying to deal with recruitment for public service.

# CLOSING PLENARY SESSION

*Wednesday, December 14*

## Morning Session

***Chairman***

**Harry E. Schlenz**

***President, Pacific Flush Tank Company;***
***Vice President, Water Pollution Control Federation***

The Conference this morning formally receives the reports of panels I, II, and IV. These reports will be presented by the Chairmen who presided over these particular panels on Tuesday. Last evening, while most of us enjoyed a leisurely dinner the members of the subcommittees assigned to each of the panel groups, worked for many hours to summarize and translate into specific terms the views, suggestions, recommendations, aims and goals expressed in the formal papers and discussions.

It was also the responsibility of the subcommittee of each of the panels to consider and summarize all questions and answers as well as statements made from the floor following each of the program addresses presented on Tuesday.

Following these procedures of the subcommittee, the staff personnel, working into the early morning hours, transcribed these reports which were then distributed to and reviewed by all of the members of the panel subcommittee early today.

At the conclusion of each summary report there will be an opportunity for discussion and questions from the floor.

In closing, the chairman takes this opportunity to remind the National Conference on Water Pollution that it is not the specific obligation or purpose of those here in attendance to formulate or introduce resolutions or motions to be acted upon at this time. All papers and discussions, including questions and remarks from the floor, will be included in the proceedings to be published following the Conference. These will be distributed to all those who have registered and others concerned.

The report of panel I will be given by the Hon. Thomas A. McCann, who presided yesterday over the interesting sessions of that panel.

## Subcommittee Report, Panel I

### Hon. Thomas A. McCann

Neither the extent nor the effects of water pollution are sufficiently known to permit precise agreement at this Conference on the topic assigned to panel I, "Water Pollution and Our Changing Times; Effects of Pollution on the National Health, Welfare and Economy." But an analysis of the papers and discussion indicates that the future quality of our water resource and the range of human needs the resource can serve can be as high or as low as we wish it to be, depending on the values we wish to protect and the price we are willing to pay.

Known threats to human health from water pollution under existing treatment levels are not seen as catastrophic by public health officials; but better knowledge of the short- and long-term effects of pollutants may show dangers where none are now anticipated.

Certain minimum steps are indicated to minimize threats to public health from pollution: investigation of potential health hazards as an integral part of development of processes and products producing pollutants, and preservation of uncontaminated water supplies and regulation of waste disposal.

The information needed to protect public health can be obtained only by the combined efforts of public and private interests, inspired by a keen sense of responsibility for water quality. Government responsibility in fact finding should be exercised in a strong and foresighted manner in order to provide sound bases for action programs. Examination of the public health consequences of technical and industrial processes must be a regular and necessary part of research and development. The eventual cost to our society of achieving hygienic security will be much less than the potential cost of dealing with the effects of pollution.

Effects on recreation and esthetic values are difficult to measure because the judgments on use of water for such purposes are subjective.

Impacts of pollution on fish and wildlife are extensive. The United States Fish and Wildlife Service has stated that the area of habitat rendered unproductive each year by pollution is greater than the habitat established by all public agencies conducting wildlife restoration programs.

Impacts of water pollution on industry are difficult to generalize upon because of the almost infinite variety of industrial uses. The largest industrial use is for cooling, where a wide tolerance in quality is permissible. In food and pharmaceutical manufacture, on the other hand, standards well above those for drinking water may be necessary.

Industrial management does not often seek public action to protect its water supply; it is reported as inclined to accept the burden of treating the water it needs for its processes. Industrial management, for the most part, believes that pollution of industrial water supplies will not increase to more critical levels in the near future. Water quantity and quality are important in plant location decisions; so is the extent and cost of pollution abatement which is likely to be required of industry.

The problem of evaluating pollution—of finding acceptable ways of comparing costs and benefits—is very difficult, but must be resolved if specifics are to supplant generalities as a basis for the establishment of sound public policy. Documentation of pertinent kinds of water quality deterioration is necessary. The prime difficulties are that various pollutants cause varying kinds of water supply deterioration; and measures of pollution effects vary with the values being considered. A pollutant damaging to recreation may be harmless to industrial users.

A precise definition of the different kinds of values with which we are concerned is essential. At least three kinds of values must be considered—health values, recreation values including esthetic values, and market values. The relative importance of these values will vary with changing demands.

Measurement of physical and biological relationships—to relate water quality to volume, temperature, etc., as well as to the usual problems of waste disposal—is essential.

In consideration of the impacts of water pollution on our changing times, the subcommittee members assigned to panel I have prepared a series of recommendations designed to protect and enhance the values of the water resource. The subcommittee believes that the following recommendations are reasonable and warrant vigorous implementation—

1. We recommend that the Conference express its conviction that the goal of pollution abatement is to protect and enhance the capacity of the water resource to serve the widest possible range of human needs, and that this goal can be approached only by accepting the positive policy of keeping waters as clean as possible, as opposed to the negative policy of attempting to use the full capacity of water for waste assimilation.

2. There is need for a more systematic approach to the evaluation of water pollution problems, to include health, esthetic, and market values. A framework for analysis must be developed which will provide a relatively precise understanding of benefit-cost and which will

form the basis for the design of public policies and programs for effective water quality management.

3. States should develop water monitoring programs for bacteriological, biological, chemical, physical and radiological quality. This work should be coordinated with the efforts of an expanded national water quality network of the Public Health Service. More data should be collected on the condition of streams both before and after water pollution abatement.

4. The construction of municipal waste treatment facilities should be expanded immediately with continued increases to keep up with population growth and to abate the backlog of pollution by 1970. A similar program expansion should be applied to the wastes from industry.

5. Each Federal installation should be required by Congress to treat its wastes in accordance with the standards for cities and industries in the area, with 1964 set as the target date for providing minimum treatment.

6. It is recommended that improved methods be developed for measuring pollution abatement progress. New engineering parameters which encompass all pollution components, as well as yardsticks for measurement of stream quality, are critically needed.

7. The administrative level of the water supply and water pollution control activities in the Public Health Service and in the States should be commensurate with the importance of this problem.

8. We recommend that public policy formally recognize the recreation value of our water resources as a full partner with domestic, industrial, and agricultural values in water quality management policies and programs.

9. We recommend that appropriate public and private agencies mount and sustain an expanded program of public information to the end that enlightened public opinion can be brought to bear on the accomplishments, costs, needs, opportunities, and problems involved in water quality management, noting that this Conference should provide a dramatic opportunity to launch such a program.

10. It is recommended that the Public Health Service assume leadership, in collaboration with other public and private agencies, in collecting, compiling, and publishing pertinent data on the toxicity of water contaminants. This should include criteria, standards, methods of testing, and safe allowable concentrations for human consumption; also that efforts be made to stimulate toxicological and epidemiological studies to be made to determine long- and short-range effects.

11. In order to facilitate assessment of the total pollution problem, it is recommended that particular attention be given to accelerating the collection of information on industrial waste loading. The Public Health Service should coordinate collection of this information on the national level.

12. The Conference feels that financial incentive should be provided to encourage industry to install needed waste treatment facilities. This may be accomplished by permitting industry, for corporate income tax purposes, to charge the cost of nonproductive waste water treatment facilities as an expense.

The members of the Panel I Subcommittee, in addition to the chairman were: the Co-Chairman, Dwight F. Metzler, Kansas State Board of Health, American Public Health Association, Chairman, Conference of State Sanitary Engineers; Leland C. Burroughs, Shell Oil Company; Irving K. Fox, Resources For The Future, Inc.; Seth Gordon, Conservation Consultant, California State Department of Fish and Game; Frank Gregg, Izaak Walton League of America, Inc.; Mrs. E. Lee Ozbirn, General Federation of Women's Clubs; A. J. Steffen, Wilson & Company, Inc., National Technical Task Committee on Industrial Wastes; Harry E. Schlenz, President, Pacific Flush Tank Company, Water and Sewage Works Manufacturers Association; and Dr. Russell E. Teague, Kentucky State Department of Health, Association of State and Territorial Health Officers. The subcommittee was assisted by these PHS Resource Personnel: W. E. Gilbertson, R. S. Green, J. R. Harlan, and J. H. Svore.

## GENERAL DISCUSSION

### Panel I Report

**Mr. SAMSON.** I have one question in connection with Mr. Metzler's remarks on Federal installations. I wonder if this panel in its prodigious labors considered whether or not a Federal installation of any type should submit the plans and specifications of its disposal of human and industrial or any other wastes to some other duly constituted and proper governmental authority for approval.

**Mr. METZLER.** The answer to this question is that we did not consider this specific subject. On the other hand, the first paper in the series, which was presented in Panel I, recommended that the treatment works at Federal installations meet the same standards being met by the municipal and industrial facilities in the same general area. To me this carried the connotation that the Federal installations submit their plans to the State water pollution control authority for review to determine that they did a reasonable job of meeting those standards set for others in the vicinity. It is a very good question, Mr. Samson.

Some of you set 1965 as the date for achieving this goal, but we felt the program could be accelerated and advanced the date to 1964 after considerable discussion. There was a feeling among the delegates that 1965 was too far off, and I heard a good deal more suggestions for 1963 than I did for 1965.

**Dr. ELDIB.** (Dr. I. A. Eldib, Esso Research & Engineering Co.). I have two points to bring out. I know it is practiced in industry, at least in the laboratory, that there are certain things you can throw in the sink and other things you cannot. We have cans sitting on the side, and one uses his judgment as to whether to use the sink or the receptacle. I wonder if it is possible to do this on a national, domestic basis. In other words, people would know that this is the kind of thing they throw in the sink and this maybe they ought to keep in a can of some sort and the garbage man comes and picks it up in a tank.

**Mr. McCANN.** Let me say, Dr. Eldib, we probably had the best help of any panel that has been charged with any responsibility. We happen to have the charming president of the American Federation of Women's Clubs, Mrs. E. Lee Ozbirn, and this will be an item in their program. She has accepted the challenge of putting over public awareness of the problem, under which your suggestion would come, an educational program as to the kind of waste and what to do with it.

**Dr. ELDIB.** Just one more point. Is it possible to issue little posters at home similar to what civil defense has distributed, on what certain signals mean, so that housewives can put the poster close to the kitchen sink and go down the list so they know the things they should not throw in the sink?

**Mr. McCANN.** I think it is very good, and we will call on the Advertising Council of America to help us in this. That was discussed in our panel; that they could be of a lot of help to us.

**Mr. METZLER.** There is a question from C. S. Moore, of E. I. du Pont de Nemours & Co.: ***"What attention was given by the panel to the most important consideration of cost and relative value between the various areas of pollution abatement?"***

I recall that this came up on at least three separate occasions. One was when Irving Fox made the suggestions which led to recommendation No. 2 of the panel, and, if you will permit me, I will read that one again:

> There is need for a systematic approach to the evaluation of the water pollution problems, to include health, esthetic, and market values. A framework for analysis must be developed which will provide a relatively precise understanding of benefit-cost and which will form the basis for the design of public policies and programs for effective water quality management.

On the other hand, there was considerable opinion (and perhaps no precise agreement on the point) that there were some benefits to clean water which were far above and beyond our ability at the present time to measure on a cost-benefit basis. This led to the first recommendation which I gave for the panel—that we make every effort to protect and enhance the quality of the water resource by keeping pollution in all instances at as low a level as practicable.

This question from Prof. E. R. Baumann, Iowa State University: ***"What attention was given to recommending a river-basin concept of handling water pollution and water resource problems with greater coordination of efforts of all organizations interested in water?"***

The river-basin concept of handling problems, I think, was almost taken for granted in Panel I, although, so I recall, there was no specific discussion of this particular point. This is a good question, and I think probably the members of the panel would assume this is a valid way of handling water pollution and water resource problems.

## Subcommittee Report, Panel II

**Dr. E. A. Ackerman**

The members of Panel II regard their assignment as one of the more difficult at this Conference. An analysis of pollution control as a means of increasing water supplies requires a great deal of the information and expert knowledge which came forth in panels other than this. Our panel's question is complex because we not only must know what the present dangers are, but also what impacts various types of pollution will have in the future upon the Nation's water supplies. We must know what the future needs for water will be for specific purposes, and total demands as they extend into the future. We must know how pollution control measures are to be handled, and how they will fit into our legal and administrative systems. This job of analysis is not one which we have taken lightly.

Participating with us in our panel sessions and deliberations have been representatives from all major regions of the country. We have listened to lawyers, legislators, engineers, administrators, geologists, biologists, and chemists. Included in these have been Federal Government officials, State government officials, municipal officials, and men from private industry, private foundations, and trade associations. Speaking for the panel subcommittee, I should like to state its consensus in comments on three broad questions: (1) How much do we know about water pollution? (2) What can we see for the future? and (3) In areas where other water needs exist, or may be reasonably anticipated, what should be done to minimize waste disposal demands upon water resources?

We already know more about pollution and pollution control than we put to practical use. As Mr. Powers observed in our session, there are many water quality intelligence programs in this country.

These include those of the U.S. Geological Survey, the newly established National Water Quality Network under Public Health Service supervision, regional projects like the Ohio River Valley Water Sanitation Commission, and numerous others of a local information-gathering nature by private industry and municipalities. Through these means we have a reasonably broad picture of stream contamination by microbiotic organisms as indicated by the coliform bacteria, and much specific knowledge of the inorganic and organic contaminants of industrial origin usually found in urban areas or in densely settled regions.

We have a reasonably good picture of the control of pollution from natural causes. Indeed, the reduction of sediment in streams, and the control of undesirable dissolved solids in streams, may offer major opportunities for water improvement.

Carl B. Brown, of the Soil Conservation Service, stated, ". . . . silt pollution is a major deterrent to the effective development of the water resources of most drainage basins in the United States." He further estimated that annual losses from silt pollution may be on the order of $350 million a year for the country as a whole. Mr. Brown also pointed out that substantial amounts of our reservoir capacity are lost every year from silt or from sedimentation. He further noted that about two trillion gallons of water must be filtered annually to remove suspended silt. We know the sources of much of this sediment, and even the type of erosion which causes it. Within recent years even metropolitan areas have been adding their increment to the sediment load of streams, as suburban development has soared.

Yet there are many things which we do not know. According to Mr. Klassen, for example, adequate analytical methods do not exist to determine the quantitative presence in water of 400 new substances for washing clothes, cleaning cars, killing weeds, controlling insects, and other uses. According to Mr. Klassen and Mr. Cunningham, we need to accelerate research on viruses and means of their control as an additional safeguard to potable water supplies. Dr. Cottam pointed out that we do not even know the total consumption or production of all pesticides. Mr. Klassen observed that present laboratory methods for determining water quality compliance are, in most instances, giving us nothing more than a history of conditions that existed one or more days previously. Methods are needed to determine what conditions are at a given moment so that better knowledge of hazards to water can be ascertained.

Finally, treatment processes presently available for use in urban waste disposal are less than 90 percent efficient. For that reason, treated wastes cannot be discharged to receiving streams without deterioration of quality. Economically feasible "totally complete" treatment has not been developed yet.

If there are gaps in our knowledge of the present, it can be expected that the gaps are even larger as we look at the future, the contours of which we need to appraise in answering the questions put to this panel. Surprisingly, however, we do have some important information in this respect. Recent inventories of the relation of water resources to future demands indicate that on 22 major watersheds of the Nation five will show a deficiency of supply as compared to projected needs in 1980. This means that for these five basins there will be a demand for water which can be produced through the techniques of reuse or pollution control. Already some such water is in use in these basins. The greatest prospective deficiency occurs in the Southwestern States and it is there that quality control to permit water reuse becomes essential for future economic development. Before the end of the century three more basins, the Western Gulf, the Upper Arkansas-Red River Basins and the Western Great Lakes area, are expected also to become deficient areas. On the other hand most drainage basins east of the Mississippi and those on the Lower Missouri, the Lower Arkansas-White-Red, and the Columbia show adequate supplies, with proper conservation and normal control measures, even at the end of this century.

This situation does not describe many difficult sub-regional and local situations. The general outline is such that Mr. Banks stated: "We have reached the point where any use of water that does not give optimum economic and social return is wasteful. Maximum use with minimum quality deterioration must be our goal if we are to so budget our water expenditures that the available supply will be adequate to meet our growing needs."

Probably for this reason several endorsements of comprehensive development were made. Descriptions were given of the process of comprehensive planning as it is now being carried on for the Southeastern river basins by the U.S. Study Commission, Southeast River Basins. Such development has progressed systematically within a few River Basins, like the Columbia, the Colorado, the Central Valley, and the Missouri. Completed planning studies for comprehensive development have been made in additional basins as for the New England-New York basins, and those of the Arkansas-White-Red River basins. In addition to the Southeastern river basins, studies are in progress for Texas rivers and in the Delaware basin.

The progress of comprehensive development is of substantial interest to those interested in pollution control. It is basic to any knowledge of the extent to which pollution control will be needed as a source of water. Only through comprehensive planning can we obtain an estimate of total needs over a reasonable future period. Only through comprehensive planning can we obtain an intelligent picture of alternative sources to meet these needs. At least two speakers defined comprehensive development in terms of plans which aim at the maximum benefits for all purposes. One suggested that this be in terms of the maximum contribution to Gross National Product.

There is more to comprehensive development as it has been conceived by the speakers than engineering and technical organization. A legal and administrative structure which will permit the progress of such development and management is a question requiring serious attention. Even though comprehensive plans may be proceeding or have been finished for a number of important river basins, the legal support necessary to carry out comprehensive water management to the fullest, needs study and attention. Our legal structure may or may not be compatible with the needs of comprehensive development. Thus the concept of water quality rights was introduced by Mr. Banks as almost certain to be a needed part of the legal structure of the future. In many of our States we now have water quantity rights, although not in all, but water quality rights need defining and legislative sanction.

It appears inevitable that as water quality deteriorates and interferes with established uses of water, litigation regarding water quality will increase in frequency and magnitude. Water quality rights, therefore, will achieve greater recognition and more precise definition.

In connection with these rights the question of water quality standards arose. Some speakers stated quite emphatically that no standards of water use could be applied to the entire country; indeed, that each community, or each river reach, presents an individual problem in water quality standards. Others felt that this may be a somewhat narrow interpretation of water quality criteria. There are certain standards which can be nationwide, indeed, universal. Thus, our knowledge of pathogens can tell us what will make people ill anywhere, and permissible levels of radioactivity will be the same anywhere. However, there are a number of criteria which can be of interest only locally or regionally.

Out of these and many other interesting and significant statements which were made in the course of panel II sessions the subcommittee has developed a few recommendations which it offers to the Conference.

The panel recommends the following measures to facilitate the control of pollution in the Nation's streams and underground waters:

1. *Comprehensive development*

Planning for the comprehensive development of each major basin or water resource area should be established as a fixed national policy. By comprehensive development we mean the application of integrated multiple-purpose design, planning and management which include the joint consideration of ground and surface waters, systematic conservation by water users, and the treatment and management of waters having substandard quality. Consideration of every appropriate technique would be a routine part of planning for such development.

Such planning, insofar as feasible, should include consideration of all important industrial plant sites. An early and important objective should be a systematic program of flow regulation. State initiative toward comprehensive planning should be encouraged, and participation by all major interests should be encouraged. The objective should be one of eventually producing maximum total benefits from all economic and social uses.

### 2. *Reservoir site acquisition*

Provision should be made, legally and financially, for the identification and acquisition at an early date of reservoir sites needed in the execution of comprehensive plans. The mounting population, the spread of settlement, and general intensification of valley land use otherwise may make many good sites totally unavailable or prohibitively costly.

### 3. *Water quality criteria*

Provision should be made within the Public Health Service for developing the water quality criteria which are suited to application on a national basis. However, many water quality criteria are not uniformly applicable because of the effects of area usage differences, stream characteristics and other factors. State and local determinations of some criteria also will have to be made. It is recognized that periodic revision of these criteria not only will be in order, but should be sought, as new data are made available.

### 4. *Water quality monitoring*

Enlargement and extension should be made of the water quality monitoring programs now in effect, so as to reveal more adequately conditions, existing and future, in rivers and streams. We believe that the protection of the public health and the preservation of water supply sources for accepted beneficial uses require such extension and enlargement.

### 5. *A national credo*

We recommend the adoption of a national credo, to be given as wide and consistent publicity as is feasible. The content of the credo would be—

(*a*) Users of water do not have an inherent right to pollute; (*b*) users of public waters have a responsibility for returning them as nearly as clean as is technically possible; and (*c*) prevention is just as important as control of pollution.

### 6. *Basic research*

It should be regarded as an obligation on the part of industry to undertake basic research which will determine the biotic and other effects influencing the public welfare of the products they distribute. This should apply to detergents, insecticides, pesticides, herbicides, fertilizers and other microchemicals and microbiologicals, and to the effects of metallic wastes such as compounds of chromium and cyanide. Where the effects of these or other health hazards or potential public nuisances are not adequately treated within industry, the Federal Government or the States must provide for and budget such research. Additional research of peculiarly public responsibility includes the effect and interpretation of reducing anaerobes, nitrifying bacteria, viruses, protozoa and other biota, and radiation hazards.

7. *Sediment and salinity control*

The value of soil conservation, sediment control, and salinity control as pollution abatement measures should be recognized through planning and budget in our National, State, and local resource development programs. They should be considered as tools to be applied in water development and management. Pollution abatement is a problem with roots in rural land use and agronomy, as well as in urban congestion and industrial growth.

This ends the recommendations and the report of the committee, but, in closing, I should like to commend a few words to your attention which cannot have the approval of any committee as yet. The reason is that I thought of them this morning. I felt I should like to say them, if the chairman will permit me. And I present them on my own. They are comments of two different sorts. The first relates to the use of the word "budget," which appears in our recommendations. This may seem to call for appropriation increases and, indeed, it often does, as has just been noted for research. This is one very valid area for appropriation increases, where there are new things for which we have not as yet any means.

But there is another side to this word "budget," that should always be kept in mind. Whenever any budgetary increase is suggested or asked for in a public program, I believe that the recipient agency or agencies have an obligation to think about efficiency—not only to think about, but reconsider efficiency—in its operations. Because of the many and mounting obligations which this Nation has, and, even more, will have, there will be special need of this in the future if we are to do the job that will face us.

The other comment is of a somewhat more philosophical nature. A few days ago I read a few words which tell the thought of a famous statesman and a national leader of the present day. Perhaps these words might apply to that recommendation which I submitted on the national credo, and I quote him—

> Can you imagine a good life which does not have an artistic and esthetic element in it, and a moral element in it? That would not be a good life. It would be some temporary phase of existence which would be rather dry and harsh.

I would say there is both an esthetic element and a moral element in pollution control. And I think we need to consider it, as we go about our business in presenting this to the Nation, because I feel we need to prove our interest before the eyes of the world in nonmaterial as well as in material things.

This may not be an original thought, but I think it is one that bears consideration every day in our lives, as they are very much interconnected with the rest of the world in the future.

I personally happen to believe that a discordant environment is not conducive to peace in a man's soul. And pollution certainly contributes, I think, to what I should call a discordant environment. I do not feel that we as a nation or as individuals can be what we want to be, that is, efficient, productive, and humane, if we are not at peace in our souls. So here, in addition to the many technical things, we in this Conference are talking about some very fundamental things in American life, and I think we should let other Americans know it.

The members of the Panel II Subcommittee, in addition to the chairman were: Co-Chairman, Ray E. Lawrence, Partner, Black & Veatch, Consulting Engineers and President, Water Pollution Control Federation; L. W. Cadwallader, Potomac Electric Power Co. and Edison Electric Institute; Louis Clapper, National Wildlife Federation; Morrison B. Cunningham, Oklahoma City Water Department and American Water Works Association; Roger Hale, Conservation Foundation; Page L. Ingraham, Council of State Governments; H. Wayne Pritchard, Soil Conservation Society of America; David F. Smallhorst, Texas State Department of Health and State and Interstate Water Pollution Control Administrators; and Gordon K. Zimmerman, National Association of Soil Conservation Districts. The subcommittee was assisted by these PHS Resource Personnel: K. S. Krause, W. W. Towne, and L. F. Warrick.

## GENERAL DISCUSSION

### Panel II Report

**Mr. LAWRENCE.** This question was asked by Charles P. Beazley, and is addressed to Dr. Cottam: ***"Why not establish a pesticide control commission composed of representatives of the Public Health Service, Agricultural Research Service, and Food and Drug Administration to police pesticide pollution?"***

**Dr. COTTAM.** I am in sympathy with the objectives of the person who asked that question. I share his feeling that there is need of a better degree of coordination in the use of pesticides than we have yet experienced. I think we are a long way from having the type of coordination that is needed. In my personal opinion, that cannot be supplied by another commission. The authority of law must precede this. If there were a commission, I would assume it would be under the direction of the President. I feel the great need is for a national declaration of policy by the Congress on the use of pesticides. If we had that kind of thing, I believe then there could be the effective vehicle we desire. The departments of our Federal Government already have every opportunity of a coordinated approach if they want to take it. Coordination now exists on paper, but it is ineffective and all authority seems to rest solely with those broadcasting poisons. I think if there was a declaration of policy by the Congress, we would be more likely to see some degree of coordination brought about.

When you deal with these poisons that have recently been developed (I cite one case, endrin, as an illustration), the situation is serious. That poison is so toxic that six-tenths of one part per billion will kill one-half the fish (bluegills) in a pool in 96 hours, as shown from laboratory experiments.

To put it in terms that the audience can understand, five-thousandths of 1 pound is sufficient to kill one-half of the fish in 3 acres of water 1 foot deep.

When you are dealing with things as toxic and as dangerous to human health as well as to our natural renewable resources, as this type of chemical, and it is left to the determination of the pest control operator to spread it willynilly as he wishes over the countryside—and they are doing it in tremendous quantities by airplane and by ground equipment—I think it is perfectly obvious that there are dangers to public health.

We have reached the point, because of the high toxicity of some of these substances and the dangers involved where we need a national declaration of policy by the Congress of the United States on safe standards for their use. There would then be need of a coordination committee among the different Departments. As I remember, the proposed statement called for Agriculture, Public Health, and Food and Drug Administration. I believe the Fish and Wildlife Service should be included also or someone to represent the fish and wildlife resources of the Nation.

As evidence of the need of this from last June through September, the Public Health Service conducted, with the cooperation of the State health departments and the fish and game departments of the several States, and the water pollution control commissions of the several States, a survey of the fish kills in the various States, not only because of the importance of fish kills as an economic resource, but as evidence of serious stream pollution.

If I remember the figures, there were 28 States which did take the time to report in the 4 months and others are coming in. Of the data I have read concerning the 28 States, there were more than 200 rather serious fish kills, and in one case more than 5 million fish were killed. Some of those were complete kills in several miles of river or stream and some of the commonly used pesticides were responsible. Endrin was one of the principal sources of contamination. When it is as widespread as that, I think the implications go much further than the renewable resource, as important as that is.

I believe we need a declaration of policy by the Congress, and I do not believe this will be resolved until we get a frank and clear definition of policy as we have at the present time in just a few States. The control agency of the Department of Agriculture can have all the advice from the fisheries and wildlife people they wish. Then they can take it or leave it and they usually leave it. They seem to have full authority to go and spread the poison in any quantity they want, and they have done it, and are doing it.

**Mr. BEAZLEY** (Charles P. Beazley, Applied Science Laboratories). That was my question that you just read. I agree with the good doctor's premise about Fish and Wildlife having a representative on the Committee, and I think we ought to have a very firm and very positive national policy like we have with regard to food and drug consumption; but why not have some organization that can prohibit the use of Endrin right now or next month, and get rid of some of these bad pollutants and pesticides that are destroying the fish and wildlife?

Twenty years ago we didn't have all these substances and we managed to live. We can do it again if we can get some organization like the Food and Drug, which is doing a terrific job in keeping poisons off the market and controlling their abuse.

**Mr. LAWRENCE.** The next question is submitted by Mr. Francis Silver. It is in the same general area of interest. It is a question addressed to Dr. Dean. ***"In the discussion last afternoon you stated that the public had decided that they preferred pesticide residues in their apples to worms. I was under the impression that this was a bureaucratic decision in the Food and Drug Administration which interprets insect fragments and excreta as 'filth' under the 'no filth' clause of the Food and Drug Act. Can you tell us on what you base your opinion that the public was ever given the opportunity either at the market place or through legal channels to decide between worms and pesticide residues in food and water?"***

I think the real comment on the part of Dr. Dean yesterday was the fact that it was important, of course, that we keep worms out of the apples. I don't think he had in mind that we were consuming the pesticide residue. But I am not capable or qualified to comment on this question. Since Dr. Dean is not present we will proceed with the next question.

The next question is submitted by Everett L. Maynard, and it is in two parts. I will ask Gene Weber to answer the first part and I will ask Mr. Brown or Mr. Zimmerman to answer the second part. I shall read part 1.

***"What is the feeling toward a type of zoning to prevent building, etc., too near a stream which results in silting and other pollution to a water supply?"***

**Mr. WEBER** (Eugene W. Weber, Special Assistant to the Director of Civil Works, Office of the Chief of Engineers, Department of the Army, Washington, D.C.). I am not the best qualified person to try to comment on that question, Mr. Chairman. I am one who believes we could benefit from proper planning—that is zoning which would prevent silting and zoning which would prevent misuse of lands that contribute to pollution. I think this particular point on zoning is one which should be considered by particular State and local authorities which have that responsibility now.

**Mr. LAWRENCE.** Let me ask you to comment on part 2 of this question.

***"Should we consider leaving as much of our restricted watershed in natural vegetation?"***

I think there may be a word missing there, but I think the questioner would like to know if we should set aside and restrict substantial portions of the watersheds to natural vegetation.

**Mr. WEBER.** I will go out on a limb on this one and say that I think it unlikely this would be the best solution in many instances. In my opinion we should find out the best use for all our lands and plan that use in such a way so that all the needs for the use of the land and the water resources could also be accommodated. I stress the word "use" rather than lack of use.

**Mr. BROWN.** I will take the liberty of commenting also on the first part of the question. I would interpret the question phrased in terms of zoning of construction to really cover the situation of finding some means by which the construction activities so prevalent in our metropolitan areas could be brought under building regulation controls, so that the production of silt would not be so great as it is today. One of the problems that has arisen, particularly since World War II, has been that of clearing off vast tracts of land, often of several hundred acres, for the construction of large housing developments, by completely cleaning off the entire landscape. This practice did not generally exist prior to the war. We believe this practice is, in part, fostered by existing local building regulations and possibly by requirements of FHA and other organizations. We believe this problem seriously needs looking into as a means of controlling silt pollution coming from construction erosion which, as I pointed out in my paper yesterday, is some three to six times as great as that which occurs normally on agricultural land.

In responding to the second part of this question, the position of the Department of Agriculture has been to foster the multiple use of watersheds. I might mention that at the last session the Congress enacted what is known as the multiple-use act of 1960 (Public Law 86–517), which expresses the position of the Department that land in a watershed should be used in accordance with its capability for multiple objectives.

We believe that land which has a type of condition that dictates it should be in permanent cover should remain in permanent cover, such as forests. That land which is capable of other uses in addition should be used with the needed conservation practices applied to it.

**Mr. MOORE.** May I comment on that. I have a specific suggestion which might be particularly interesting to the group.

At the recent Brandywine Valley Association annual meeting, at Longwood Gardens, Pa., a proposal was offered for our particular consideration by William Whyte, Jr. It is in use in California and concerns the procurement by suitable individuals or local authorities of easements for the preservation of the land in a particular fashion.

He proposed that the land adjoining the Brandywine Creek be purchased by the use of the easement procedure so it would remain in the existing use or under-controlled use. This easement would be continued through the life of the property. Property would be used as it is now being used or improved as needed, so that there would be no encroachment or development, either by industry or by urbanization, and that the quality of the water as well as the scenic values would be maintained. I am sure that this facility or legal mechanism could be applied in instances described or brought out by this particular question. These easements would be obtained and held by the community. The people, as an incentive to sell easements of this character, would be given concessions in the area of taxation and the evaluation used on their property.

**Mr. LAWRENCE.** The next question is from Roland C. Clement, National Audubon Society: ***"Did Panel II agree with Panel I in recommending quality controls as high as practicable rather than emphasizing the loading capacity of streams?"***

I can answer that by quoting from the recommendations from panel I.

> We recommend that the Conference express its conviction that the goal of pollution abatement is to protect and enhance the capacity of the water resources

to serve the widest possible range of human needs, and that this goal can be approached only by accepting the positive policy of keeping waters as clean as possible, as opposed to the negative policy of attempting to use the full capacity of water for waste assimilation.

I would say the discussions and the deliberations of panel II were in substantial agreement with those which I have just read, although perhaps not in the same language.

The next request is from D. W. Cannon, of the National Association of Manufacturers, who would like to make a statement.

**Mr. CANNON** (D. W. Cannon, National Association of Manufacturers). I tried to write down as best I could what the recommendations of the panel subcommittee were but I may not have all the words exactly correct. I find some disturbing implications in some of the language used, and I would like to raise some questions concerning them. I believe I speak for others in not being in agreement with everything that was contained in those recommendations.

The first recommendation on planning for comprehensive river-basin development as a fixed national policy seemed to include heavy emphasis on multipurpose development, whereas I am not always sure that the big multipurpose dam is always the best approach to some of our soil and water conservation problems. In many instances the sound approach for watershed development is through such upstream measures as proper land treatment and water retardation, in order to conserve both soil and water and eliminate floods. So advocating this as fixed national policy, which seems to advocate it as a uniform solution to all problems all over the country, I think, is somewhat questionable.

Also, there appeared to be included some reference to the industrial plant site locations, and I don't wish to introduce a discordant environment, but if this seems to endorse the idea of governmental dictation of industrial plant site locations, I heartily disagree with that approach and I think others would, too.

I also think that there are some dangers in the recommendations on the water quality criteria. There seemed to me to be undue emphasis on the Federal approach of formulating nationally applicable criteria, and even though there was some encouragement given to some formulation by States and localities of local criteria, it seems to me that this overlooks the varied conditions that must be confronted in all the various areas and regions of the country and the complexity of the problems that vary so much from one area to another.

I also have some question about the language contained in the recommended national credo. I believe it contains the phrase "as nearly clean as is technically possible." And I particularly wonder about that in connection with the financial burden that this may impose upon the municipalities of the country. I am wondering if this is meant to suggest a requirement that municipalities may be required to up their B.O.D. removal from 85 to 90 percent to 95 or 99 percent, or just what is this technical perfection to which the municipalities will be required to comply, apparently regardless of cost to the local taxpayers? As I understand, these are the recommendations of the panel subcommittee, and I wish for the record to show that they are not unanimously acceptable to all of us.

**Dr. ACKERMAN.** I think this does call for a comment on my part in defense of the subcommittee. Perhaps we were not clear enough in our language, and if we weren't, you will have to excuse us for it. Mr. Cannon has put an extreme interpretation on these things which we did not intend. I should be extremely sorry to have them stand as stated since they infer a point of view on our part that we did not have.

As far as multiple projects are concerned, there is something more to multiple-purpose planning than simply the big barriers or dams that are known as the multiple-purpose projects. True multiple-purpose planning, as we shall see it in the future, involves the consideration of all purposes for an entire watershed or basin. It in no way eliminates single-purpose projects or upstream approaches, but it does recommend a balanced consideration of the situation. If Mr. Cannon was suggesting that we abandon our ideas for plans for multiple-purpose, major structures in the lower reaches of the stream, that is especially undesirable.

Another point of view which we did not have, is implied in the remark about Government dictation of industrial plant sites. Again, this was not our intention. I should be very pleased if Mr. Cadwallader would speak on this since he is an industry man, and he originally suggested it in our subcommittee. We may not have stated this exactly as he wanted it. I am sorry that he is not in the room. He would give an interesting industry point of view which would show no fear of Federal Government dictation in this field. Nor does the subcommittee want it. Yet it is important that all of us—Federal Government, State, municipality, private industry—get together and do some planning or at least thinking as to where industry may be in the future, and provide for it, because in the end it is going to be cheaper for industry and cheaper for the municipality.

Now, on the matter of nationally applicable criteria, there is a question of emphasis and balance again. I have no doubt (but I am not in a position to know exactly) that perhaps most of these criteria may be matters for local or State consideration. There are some, as I tried to make clear in the report for the subcommittee, which are universally applicable. If you wish to insist that levels of radioactivity or questions of bacteria and health are not of national scope, members of my panel and I would wish to argue with you on that score.

On the credo, it asks that water be returned as nearly as clean as is technically possible. What is technically possible? Perhaps we should have the idea of economic feasibility in there, too. We did our report late at night and in a short time, and perhaps there was an error of statement that we did not intend. Certainly no reasonable person (and I would like to think that we are all reasonable on this) would insist on technical perfection at great expense to any community or to the Nation. The ideal is to do what we know technically we are able to do. The major question comes on what we are able to do. It would involve more discussion than we have time for here to answer that question.

**Mr. LAWRENCE.** This question was asked by Richard Smith, U.S. Chamber of Commerce. Again I am asking Dr. Ackerman to comment, because it does relate to our recommendation No. 2, which I shall read.

***"Who should make provision to reserve sites for water storage in view of the recommendation No. 1 that calls for basin planning and State leadership?"***

**Dr. ACKERMAN.** I think a somewhat similar answer applies to this that I have used in relation to the other questions and comments. In fact, I would say that it needs more study than a panel such as ours was able to give it in the time we had. Obviously, there is a Federal Government interest as long as there is a Federal program of the extent and with the objectives of the Federal programs that we have.

In addition, I think there are State interests in this and, as I understand it, there is even one State which is going ahead at the present time in the acquisition of such sites. Pennsylvania is reported to have a program of site acquisition. Other States like California also have programs for land acquisition for public works or for other purposes looking to the future.

In addition, private industry is concerned insofar as utilities are interested in sites, too. Again here it is not one or the other, but reasonable selection among alternatives.

**Mr. SCHLENZ.** There has been a request by someone to have an indication of the number of registrants at this Conference. The number of registrants now is 1,145—which is remarkable considering the difficulties of transportation due to the snow.

In closing this morning's session, we should give a rising thanks to the subcommittee chairmen, and their working subcommittees for their fine and complete summary reports. Also, appreciation should go to those in the audience who have participated in the floor discussions and have asked questions which have added to our knowledge on this subject.

## Subcommittee Report, Panel IV

**Dr. Gordon M. Fair**

The awareness of American public authorities to water pollution reaches back no more than the Biblical span of man's life. Then, toward the end of the 19th century, as today also, it was the growing urbanization and industrialization of the Nation that forced the attention of the public to the need "for protecting the purity of inland waters." Then, as today again, it was recognized that the problems of water pollution were so complex, so varied, and so many that existing knowledge was not enough for their solution, that existing knowledge would have to be expanded in pace with the quickening water requirements of the country, and that only by the synthesis of a great variety of subjects "requiring for its achievement the organic cooperation of specialists under inspiring leadership," would satisfactory progress be attained. Then, as today, therefore, it was realized that investigators were wanted to carry on the necessary research, that money and facilities were essential to the success of a research program, and that men were wanted, too, for leadership in reducing the discoveries of the laboratory to practice.

First, the State and, later, the Federal Government were asked to conduct fundamental and applied research in laboratory and field on the relation of water pollution to the development of water resources for municipal and industrial uses, and on the sanitation of water supplies for the prevention of enteric disease.

The achievements of the generation that accepted that challenge were magnificent; so great were they, indeed, that by the end of the first third of the 20th century, the machinery of public water control could settle down in to the grooves of, more or less, complacent routine. Then came the "great leap forward" in population, and in science and industry. Faster than seemed believable, the industrial revolution of our age intensified the competition for water and, at the same time, its degradation by ever-growing and ever-varying pollutants, ranging from thermal factors through inorganic substances to organics of such construction that they cannot be metabolized by the scavenging hosts of micro organisms.

Parenthetically, it is these biological workmen to which we look for returning our lakes, streams, and tidal estuaries to natural cleanliness by themselves, or for removing even the most fractious substances committed to water by household or factory, in treatment works constructed so as to provide the most favorable environment for the operations of these beneficent microorganisms.

Once again, therefore, we are confronted by great changes; changes that demand of us the concurrent creation in adequate numbers of specialists and leaders and stimulation of research, that through analysis, synthesis, and reduction to practice will develop the technological support of pollution control that is promising of success today. To provide the sophistication necessary for a successful discussion of resources, research, and training for water pollution control in our times, the roster of specialists that was attached to Panel IV included not only engineers, but biologists and chemists, physiologists and toxicologists and economists and political scientists and, according to Dr. Gilbert White, we may have missed the boat by not including geographers and anthropologists—not only figures from universities and Government agencies, but also leaders in industry and men of affairs.

It follows that a very wide spectrum of talent considered the problems that we face in research and training for water pollution control and brings its report to this meeting.

The outlook for research is most promising because there has been a revolution in science as well as a scientific revolution. To draw a distinction between these two concepts that, otherwise, would seem to be identical, it should be explained that the scientific revolution has brought us new products and capabilities that are changing our mode of life and our environment, whereas the revolution in science is unifying the scientific disciplines and making it possible for scientists to understand one another's problems and to cooperate in their solution in radically new ways.

A striking example of the scientific revolution, as Prof. A. E. Kennelly, whose name is attached to the Kennelly-Heaviside layer, now generally called the ionosphere, used to suggest, is the fact that we can send a message around the globe in the time it took for the cry "land ahead" of the lookout on Columbus' ship the *Pinta* to reach the helmsman's ear.

To exemplify the revolution in science, we need merely to attempt to define the boundaries between the formerly well established compartments of science, labeled physics, chemistry, and biology. Today we find it largely impossible to answer a question such as "Where does physics stop and chemical physics begin?" Or, to continue, where shall we draw the line between chemical physics and physical chemistry; between physical chemistry and chemistry; between chemistry and biological chemistry; between biological chemistry and chemical biology; between chemical biology and biology; between biology and physical biology; between physical biology and biological physics; and, to come full circle, between biological physics and physics?

The destruction of the barriers between the sciences, not by interdisciplinary or cross-disciplinary cooperation, but by the fusion of the disciplines themselves is illustrated by the report that a Nobel Prize winner in physics plans to direct his future work into biology. Such indeed is the nature of the revolution that is taking place in science itself. In a sense, therefore, we have become, as a group, like medieval man who as a natural philosopher aimed at the mastery of all human knowledge.

Because of this great change in science, we can look forward with assurance to the solution of almost any problem. Among our least realized capabilities, it should be noted, is the utilization of developing mathematical concepts. Whereas the time lag between the discovery of scientific principles and their utilization has been narrowed progressively, the backlog of mathematical ideas has continued to mount. The promise of progress, therefore, remains great.

But let me turn to the specific report of the findings and recommendations of panel IV.

The panel, as you will see from the report itself, brings in certain recommendations and supports these by certain factual material.

Our first recommendation is related to the flow of engineers and scientists.

1. The flow of engineers and scientists who are competent to advance and administer the scientific, technological, and economic conservation of our water resources, including, in particular, the control of water pollution, must be increased promptly by recruitment and training of basically qualified personnel at two levels: (*a*) the professional or predoctorate level; and (*b*) the postdoctorate level.

*Now, the reasons for this are that we do not have enough engineers. We do not have enough men in the chemical, physical and biological sciences to deal with the problems that we face. We must reach over into already established scientific disciplines and entice individuals to come over into our field; very much as Dr. Glazer is being enticed by his own interests into the field of biology, we need to bring people from chemistry and biology and the social sciences and mathematics into our particular area.*

*There are about 5,500 practicing sanitary engineers of whom about two-thirds (3,700) are engaged in the development and control of water resources. It is estimated that about 280 newly trained men are needed yearly to maintain present strength. This estimate is based on an assumed five percent loss per annum by retirement, death, or defection. About 100 additional men are needed annually to keep pace with the requirements of population growth, and 350 are wanted as soon as possible to ensure the accomplishment of urgently required technological advances. This implies doubling the professional population in 12 years and doing this in the face of growing competition for prospective scientific talent.*

*Work in this field demands, for the most part, training to the masters and doctorate levels. The current annual output of sanitary engineers is about 300, of whom only about 130 have earned a master's degree and fewer than 10 a doctorate. About 25 percent of these advanced students are trainees from foreign countries, leaving about 100 with significant education in depth for employment in the sanitary engineering fields in the United States. Obviously, this is too few even for current operations.*

*The universities of the Nation award 60,000 master's degrees per year. Of these, 5,400 are in engineering and 17,000 in the physical and biological sciences. Sanitary engineering is losing out badly in competition for professional talent, therefore. At the doctorate level the situation is even more disturbing. Of the 300-odd doctorates awarded annually in science and engineering, less than 10 percent have been in sanitary engineering.*

*Data are lacking on the existing numbers of qualified chemists, biologists, economists, and political scientists in the area of water resource development and conservation. However, both quantitative and qualitative estimates point to deficiencies that are at least proportional to, if not greater than, those in the engineering group.*

*The manpower needs for research are particularly acute. If research is expanded to an estimated requirement of $20 million by 1970 and if $20,000 will sustain one investigator for one year, about 1,000 investigators will have to work in this field. If 40 percent of these are to be engineers and 60 percent basic scientists, educational institutions will have to produce 400 sanitary engineers and 600 basic scientists with academic training that qualifies them for research. The current output of only 6 to 10 doctorates in all branches of sanitary engineering is far short of meeting the need, and the competition for basic scientists is so great that a determined effort must be made to recruit needed numbers of research leaders in the respective fields related to water quality control.*

2. The capability of graduate schools or university departments of engineering and public health to produce a sufficient number of engineers and scientists who are able to deal effectively with the mounting problems of water resource control must be enlarged by support of staff, student body, and teaching and research facilities, as well as by grants-in-aid of research. Interdisciplinary research should be encouraged in particular. Because the use of personnel and the application of research lie in the public domain, the Federal Government must be expected to assume a substantial portion of the required financial burden.

*A solid look at our graduate schools shows that they are not too well prepared for such a load. The capacity of 45 schools surveyed at different times including a series of direct interviews at 23 institutions show the following: 68 schools report the availability of graduate training in sanitary engineering. Of these, 36 offer training beyond the M.S. degree. Only 15 have averaged 3 or more M.S. and Ph. D. degrees per year since 1954. An additional 17 have averaged at least 1 but less than 3 per year. Eighteen of the schools have not granted any such degrees during this entire period. This is neither a balanced nor an efficient organization in a nationally vital area.*

*The following deficiencies in capacity for research and training are estimated to exist:*

*(a) A 38-percent increase in teaching staff, and operation at optimum level of enrollment, will provide less than half the expected annual requirements for personnel training at the graduate level.*

*(b) The expectations of an increased requirement of nearly twice the present research activity is dependent upon acquiring both the added personnel for teaching and the full-time research staff, or a total staff of 144.*

*(c) To provide the desired capacity for training and research will necessitate the addition of nearly 500 qualified persons for teaching and research.*

*Corresponding increases in research funds and facilities are required to sustain needed investigators and to provide them with technical support and equipment. Only a small fraction of the Public Health Service funds devoted to medical research is going into research for water supply and water pollution control—currently less than 1 percent. A committee of Congress has estimated that the national support of needed research could and should increase to about $3 billion by 1970, and that the Federal Government should expect to contribute about two-thirds of this amount. If we apply the same growth factor to research in water supply and water pollution control, we arrive at a national research budget of about $15 million, a major part of which would have to be financed by the Federal Government.*

3. The flow of research findings on the water environment must be increased and intensified in depth as well as breadth.

*Fundamental research is needed in many aspects of water pollution control including determination of the limits to which receiving bodies of water and biological as well as other treatment units can be safely loaded for the disposal of increasingly complex waste materials; identification of the role of water as a carrier of viral diseases, such as infectious hepatitis; and studies of long-range chronic effects of trace contaminants in water.*

*We need to increase our research effort on the behavior and fate of newly introduced organic contaminants; and newly recognized viruses. We need to develop more effective means of removing pollutants from water in municipal and industrial water treatment plants; more effective process controls of industrial waste discharges; better recovery or utilization of industrial process wastes; and more sophisticated industrial waste treatment processes.*

*Water supply and pollution trends show that one of the most pressing problems in water quality management is the development of new treatment processes that will remove more of the contamination from municiapl waste waters than present methods are able to do. Currently, large quantities of water must be made available to dilute and transport the residual wastes after treatment. When this water is not available, serious pollution hazards may result.*

*To discover and develop the required technologies will demand a major coordinated research program utilizing the best minds in the country and attracting physicists; physical, organic and biochemists; toxicologists; hydrologists; economists; geographers, and anthropologists who have not up to now been seriously engaged in water pollution research.*

4. The flow of treatment-plant operating personnel as well as engineers and scientists working the wider field of water-supply and water pollution control must be increased and their training broadened.

*Two types of training are generally available: First, in-plant training of operating personnel for water and waste-water treatment works. This should be a requirement of all municipal sewage treatment works, particularly of those benefiting from Federal aid. Second, academic training of such personnel. This is available largely through short-course programs and conferences in universities and colleges. This training is most desirable. However, the means and resources are quite limited in comparison with the number of technicians that will be required within the next 15 years for pollution control purposes.*

5. The field of water supply and pollution control has become so complex that we must think more generally than in the past, of a multi-disciplinary approach to the solution of developing problems. This implies the introduction of representatives of many disciplines including economists and political scientists, as well as applied mathematicians and physicists to this field and the creation of requisite institutes or centers for environmental health research at which needed personnel can be brought together.

*Rapid changes and increasing complexity characterize our social and industrial growth. Research for the solution of today's problems calls for the group attention of scientists from the physical and biological sciences, sanitary engineering, applied mathematics and physics, and economics and political science. The making of headway is hampered by lack of communication with representatives oft hese areas. Unless a challenging program can be developed to encourage increased multi-disciplinary attention to research in this area, we must be apprehensive of our ability to cope with environmental health problems that the technological advancements of the next several decades promise to bring.*

*Sample problems are: Operations research or systems analysis of water resources developments including water quality control; integration of water purification and waste-treatment processes for maximum efficiency and economy; instrumentation for* in situ, *wide-scale, and longitudinal identification of pollution hazards and their control or prevention; automation of sampling and analysis of data; automatic computer control of treatment operations and warning systems for special hazards; and advanced methods of separation or destruction of solids in water. There are many others of like complexity and challenge that can* *be envisaged as lying before both in the immediate and more distant future.*

6. The total national support for research in water supply and water pollution control should be increased substantially.

*In research, funds and facilities are needed to sustain investigators and to provide them with technical support and equipment. Only a small fraction of the Public Health Service funds devoted to medical research is being applied to research in water supply and water pollution control—currently less than 1 percent. A committee of Congress has estimated that the national support of needed research in all fields of science and engineering could and should increase to about $3 billion by 1970, and that the Federal Government should expect to contribute about two-thirds of this amount. If we apply the same growth factor to water supply and pollution control, we arrive at a national research budget of about $15 million, a major part of which would have to be provided by by the Federal Government.*

The members of the Panel IV Subcommittee, in addition to the chairman were: the Co-Chairman, Dr. Charles A. Bishop, U.S. Steel Corporation; Dr. John C. Geyer, the Johns Hopkins University; Dr. Richard D. Hoak, Mellon Institute and Engineers Joint Council; and Felix E. Wormser, Chamber of Commerce of the United States. The subcommittee was assisted by these PHS Resource Personnel: B. B. Berger, and H. A. Faber.

## GENERAL DISCUSSION

### Panel IV Report

**Dr. BORUFF** (technical director, Hiram Walker & Sons, Inc., Peoria, Ill.). In Panel IV one of the speakers proposed, as an alternative to the Public Health Service establishing four regional laboratories for monitoring and applied research work, that this work can be placed at well-selected universities where the work could be done, and would also encourage the points that you have brought out in the report. Three of the members of the Advisory Board here on the front row would just like to see this included in your report in order that it may be given consideration.

**Dr. FAIR.** Thank you very much. We shall see that this point is included in the record.

This recommendation, incidentally, calls to my mind the excellent organization that has been developed in England to solve problems such as face us now. There, much of this work (practically all of it, as a matter of fact) is carried on by the Department of Scientific and Industrial Research through scientists and engineers which this Department recruits to itself. The scientists may be attached to the universities or research institutions. In this way, the individuals have tenure and job security and do not become dependent upon the individual university or research undertaking to which they are assigned. There is continuity also in scientific progress. Researchers can progress from one kind of work to another. This is a happy arrangement through which the talents of the country can be mustered to very best effect.

To a certain extent, this response of mine, quite subconsciously, is a partial answer also to a question by Dr. L. H. Flett in which he asks: ***"Has adequate consideration been given to using scientific advances being made in Western Europe to conserve manpower here? Can we have greater cooperation?"***

More specifically, we do have the literature from Western Europe to consult and we do use the information that is prepared there.

Greater cooperation is most desirable. This is being accomplished in various ways. For example, the Water Pollution Control Federation is not merely an American national federation, it is a worldwide federation. There is intimate exchange of ideas and information within this particular organization.

A question has been addressed to me and other panel members by Mr. Francis Silver, environmental consultant, as follows: ***"What methods are being used or developed to coordinate the toxic burden placed on humans from polluted water with toxic burden from other sources (food, air, drugs), so that the index of total actual toxicity, including synergistic effects, is monitored and not just isolated (however numerous) contaminants, or contamination from a single source?"***

This is a matter that is of deep concern to public health authorities in connection with mounting exposure to hazardous radiations. Our dentists insist on an X-ray diagnosis. The Commonwealth of Massachusetts demands that teachers be declared free from tuberculosis. That requires a chest X-ray every 3 years. Occasionally we need to be X-rayed for medical diagnostic purposes. The question is: How much of a dose do we receive in the course of a year and in the course of a lifetime? It has been suggested that we wear the necessary badges or carry a card on which exposures are noted. That, however, hardly seems practical. One is reminded too much of big brother watching us in 1984 and such, having received so many roentgens up to this particular time.

**Dr. GEYER.** In connection with this question, it might be interesting to some of those here that in September, under the sponsorship of the Environmental Sciences and Engineering Study Section of the National Institutes of Health, a conference on physiological aspects of water quality was held. The complete proceedings and discussion of this conference are in preparation, should be published in January of next year, and some of the matters implied in this question just asked will be discussed in all their ramifications in papers appearing in these proceedings.

**Dr. FAIR.** F. B. Elder, American Public Health Association, asks the following question: ***"Was any special consideration given to the gathering of information relating to research that originates in other countries, particularly Iron Curtain countries? Was there any discussion of recruitment to undergraduate engineering and sciences related to water pollution control research?"***

We know that the Federal Government is obtaining all possible published information from the Iron Curtain countries. This is merely a question of bibliographical research that any person would normally undertake.

So far as recruitment to undergraduate engineering and sciences is concerned in connection with water pollution control, we realize that we shall probably accomplish very little by trying to interest high school students in this field. The area of knowledge is a very sophisticated one. A good deal of maturity is needed to become interested in it. As Dr. Cannan pointed out so magnificently yesterday, the way in which to recruit needed workers is to have exciting work in this field going on within the universities. Using the rise in physics as an example, we find that students who formerly went into medicine, or chemistry, are going into physics today. Why? Because it is an exciting area. It does capture the imagination of the best minds. As a result, medicine is having its difficulties in recruiting superior individuals. This is true also of chemistry. This is an ancient solution which long ago found expression in the statement attributed to Emerson that if you can build a better mousetrap than your neighbor, the world will beat a path to your door.

An inquiry from William A. Hasfurther, Anne Arundel County Sanitary Commission, reads as follows: ***"Training of operators cannot be done fully in schools—greatest problem is on-the-job training. Recommendation No. 4 should include assistance to State health departments, so they can adequately staff their training sections."***

Mr. Hasfurther's statement is actually included in the supporting arguments for our recommendations. These, I did not read. We agree that plant operators should be trained at plants and that there should be a concerted effort in those plants which are receiving Government grants to see that they are operated properly.

**Dr. FAIR.** Dr. Eldib, of Esso Research & Engineering Co., asks the following with reference to Dr. Zapp's paper: ***"From the medical viewpoint, there appears to be no necessity to eliminate all contaminants from water to insure its wholesomeness. We require assurance that no harm will result from contaminants which***

***remain in water, we recognized our problem, we know what we should do about it, and we are working on it. What is being done?"***

This, apparently, is a quotation from Dr. Zapp's paper to the effect that we do not have to eliminate all contaminants. The inquirer asks: "What is being done?"

A reasonable answer seems to be that, where we know what we have to eliminate and how we can do so, we are trying to do away with dangerous contaminants, and where we do not know what needs to be eliminated we are trying to find out what needs to be done.

**Dr. ZAPP.** The statement taken from my paper expresses a fundamental fact of toxicology; namely, that a toxic effect of chemicals disappears as the concentration goes down and reaches a no-effect level. The recognition of this principle is written into the 1958 amendment to the Food and Drug and Cosmetics Act, with one exception, and that is the class of materials found to induce cancer in man or animals. So I stated, as a toxicologist, that our problem of providing wholesome water does not involve the complete elimination of contamination, but rather the reduction of contamination to levels which are recognized among experts qualified to judge such matters as being safe.

Now, the toxicity of materials is being studied on a larger scale than ever before in this country, and I might point out that information gathered in studies directed toward such things as the establishment of safe levels for pesticides on crops provides the basis for establishing safe levels of those same materials in water or, for that matter, in air, if they happen to be airborne. There should be better communication between those concerned with the safety of water, air, and food, because we, as man, are integrating our intake from all three of these sources.

I will say again that the toxicologists are not unaware of these different sources of entry into the human body. Take just one little example. It is recognized among water experts that a part per million of fluoride in the drinking water is beneficial. Yet it is almost impossible to get amounts of fluoride greater than one-tenth of a part per million into food, the reason being that those concerned with the safety of food are aware of the fact that man has already had an intake or fluoride from water and it should not be added to indiscriminately. This indicates an awareness on the part of the toxicologists of the total problem.

**Dr. FAIR.** The following is a statement by Mr. Moore, of the du Pont Co. "Despite the array of talent available, no reference was made to an immediate and colossal means for reducing the most expensive form of pollution abatement—handling that from humans. Could the panel provide a down-to-earth and practical contribution to the Conference by recommending research be done on means to reduce or eliminate human sewage at or near the origin? Industry has long been working with this philosophy."

My answer to that would be: Touché. But perhaps you would like to add to it.

**Mr. MOORE.** Yes, sir. I think that, as we have sat in these rather lengthy deliberations the last 2 days and again this morning, there appears to be a lack of what we can do today or what should we be doing in the immediate future. I certainly appreciate the rather extensive deliberations that have gone into your presentation today in Panel IV, but again I think we are confronted with problems of immediate concern in addition to those of long range. It seems to me that one of the objectives of the Conference is that of obtaining something with which people can work immediately. It seems to me that one way we can both assist ourselves in reducing the large expenditures for complex central sewage works, and in reducing the need for additional water supplies, which the people in some of the other panels have described as being a near crisis, is to reduce the amount of water that is used in our toilets. If we could reduce the amount of water used by toilets by 1 gallon a day per person, I think we would eliminate a lot of this concern over the diminishing supply that is required for domestic purposes.

I know this isn't popular, but I think we might just as well recognize that one of the ways we are going to save money and one of the ways we are going to utilize our existing supplies better is to look to the individual and convince the individual that they are wasting water at a great rate right in the home, and that they can significantly save water without any inconvenience to themselves or any compromise of sanitary conditions.

**Dr. FAIR.** It is a very interesting statement. What you are saying is that we should ask ourselves what we ask of industry.

Dr. Eldib, would you like to present your two statements?

**Dr. ELDIB.** The first statement is: To encourage private industry to enter into the field of water pollution research as a business venture, financial incentives should be worked out.

It seems to me that private industry on a small or a large scale can enter into the field of research in water pollution as a financial enterprise. In other words, something that we can make something out of, and I don't mean grants from the Government or assistance, just plain enterprise.

In order for this to take place, it seems to me it is very important for somebody (I don't know who), perhaps the Government, to define the financial incentives of such enterprise. This is the first statement.

The second statement I have is in connection with resources for research and training. The distinguished members of the panel have brought out the point that we need more engineers and more scientists, but it seems to me that this is something that will develop with time. We can't just do this right away, but there are other things which can be done right away and that is, having the Government solicit the support of scientists from industry. In other words, they might just go out and borrow some people to work for the Government on a loan basis, on a short-term basis, just to get the program started or to help bring in new ideas into the field of sanitary engineering and public health.

**Dr. FAIR.** I like both these statements and particularly the second one. The suggestion that we ask for a loan of scientists from industry seems to me to be a splendid idea.

I have one more question addressed to me, and this is: ***"Was there any discussion in the panel as to the allocation of the recommended research budget? If so, were the problems of the very small water supply (household to small industry size) and waste treatment system considered to deserve a share of this expenditure?"***

We did discuss this matter at length last night. We came to the conclusion that we were particularly interested in the promotion of fundamental research and fundamental research applies at all levels of development, the small as well as the large.

I realize that there are special problems in the technology or in the application of the research findings, but these will take care of themselves, I am quite sure, if we lay a solid foundation of knowledge on which technology can be based.

## Afternoon Session

### JOHN S. SAMSON, *Chairman*

***Chairman, Nebraska State Water Pollution Control Council***
***Member, Water Pollution Control Advisory Board***

Mr. Wolman, Chairman of Panel III on "Keeping Water Clean," honored guests, ladies and gentlemen; we come now to the last forum of the last half of the last day of this National Conference on Water Pollution which, beyond doubt, has brought together the best technical, engineering, medical, and professional public health minds of the Nation on a problem which, we all agree, demands the best that we can give it—and immediately.

How important the water situation is, as we enter the decade of the Sixties, is well demonstrated in the California citizenry's recent voting of $1.75 billion bond issue to develop that State's water resources. This is the largest such program yet devised by a single jurisdiction. In effect, it will spell the difference between continued and fantastic growth of the Nation's fastest-growing area, or its slow death for want of the necessary water to keep it alive and healthy.

Nor was such action confined solely to a single State. At the November 8 elections, citizens in other parts of the country voted in excess of $328 million in other bond issues for sewer systems construction. Some of the largest were in the two Kansas Citys; namely, Kansas City, Mo., which voted a $75 million bond issue, and across the river, Kansas City, Kans., some $15 million; Philadelphia; a number of Ohio cities and counties; Portland, Oreg.; and my own home city of Omaha, Nebr., which voted $15.7 million for construction of a sewage treatment plant. It is apparent that water resource and sewage disposal problems are showing no favorites in locale.

Neither are water supply and pollution control problems new to our era, though this Nation appears to have set some historical superlatives in the amount and extent of its problems. Emperor Justinian, who reigned over the eastern Roman Empire for some 40 years between 527 and 565 A.D., was the first ruler of recorded history to establish a modern sewage disposal plan. Among the first historical traces of sanitary engineering construction is the sewer arch which is found at Nippur, in India, which was probably constructed about 3750 B.C. A sewer running under an important street in Telash Asawr, near Baghdad "which connected with bathrooms and toilets by tile pipes," was probably constructed during the 26th century B.C. Other instances of the existence of tile drains in the pre-Christian era have been found in archeological excavations in the Old World.

So, if it be any consolation to a modern America, striving to find its way out of a water pollution complex which threatens to engulf our physical and economic health, I say to you that the problems actually are as old as civilization itself.

It is without contradiction that the dilemma of stream pollution now confronting us has greatly reduced the amount of usable water available for agriculture, industry, recreation, and public water supply.

In specific reference to panel III which on yesterday's program bore the theme "Keeping Water Clean," we must not approach this problem in a mere theoretical or academic manner, nor say, esoterically, that the responsibility for meeting the problem can be fixed definitely as that of either the States or the Federal Government.

For this closing plenary session this afternoon it is our responsibility and our obligation to meet the problem head on and forthrightly. The citizens of this great country are entitled to that kind of leadership and none less. In keeping with that purpose and premise, I now turn the meeting over to that great and outstanding gentlemen, who headed panel III in discussions yesterday and who labored with us on the subcommittee up until, I think it was, 1:30 in the morning, preparing the final draft. I want to introduce to you Dr. Wolman.

## Subcommittee Report, Panel III

**Dr. Abel Wolman**

Panel III has as its principal objective a comprehensive study of the various problems involved with "Keeping Water Clean." This broad subject included the responsibilities of Government, industry and the public in controlling the rising volume of pollution in the Nation's rivers and streams.

In opening the session on the not so innocent theme of "Keeping Water Clean," the panel chairman posed several questions as a framework upon which the discussion might evolve. These questions were not intended to cover all of the problems, but they were designed to point up some of the issues which are associated with the subject of keeping water clean. They are listed as follows:

1. How clean should the Nation maintain its river and streams; for what purpose; and at what price?
2. What are the responsibilities of private industry, as well as the local, State, and Federal Governments in keeping water clean?
3. How can public sentiment be created and maintained as part of the continuing fight against water pollution?
4. Who is to pay for the stepped-up program against water pollution?
5. What are the inadequacies of various water pollution control laws, and what should be done to strengthen these laws?

The subcommittee, following the formal panel session, pursued these questions at considerable length in order to arrive at a set of recommendations which would be acceptable to the varying points of view represented at the session.

I want to say to you, because I think the record should disclose it, that the subcommittee machinery which we were using in order to arrive at conclusions was composed of a variety of people who are interested in this very significant question. I imagine that even Justinian would not have had too much luck in getting complete unanimity out of our group because of each individual's past interests and confidence in his own personal rightness, which is one of the things we have a right to do in a democracy. No one, I think, would have expected that you could design a language or a conclusion or a philosophy which would have unanimous consent, unanimous acceptance.

We had also four representatives from the Public Health Service sitting in with us in order to supply us with the late word, any data, helping us in processing these conclusions with us. Their participation, I might say in advance, in our deliberations, was minimal. We are quite aware of the fact that there can be and probably will be charges that these arduous and enthusiastic workers in the Public Health Service may have had too much to do with either our panel conclusions or any other. I merely state to you that the subcommittee handled this situation, we believe, entirely on our own. Such help (and there wasn't a great deal of it) which the Public Health representatives provided was extremely useful to us. There was neither a guide nor a veto of any of the material which I now present to you.

You may be somewhat disturbed and perhaps even confused when I read the very first conclusion in answer to our central questions on how clean a stream should be. When I have succeeded in reading it, I want to make a comment on it and perhaps suggest even a revision. This is because of events which I shall comment on in a moment.

First, let me read what our subcommittee agreed upon as its first recommendation:

> The national goal with respect to stream protection should be the safeguarding of water quality. Every stream should be made to provide for the fullest range of uses for the type of society served and consistent with the variabilities within and among different river basins.

My attention was called this morning to the fact that Panel I found it desirable and necessary from their point of view to make similar statement with respect to clean streams. I shall now read it to you.

> We recommend that the Conference express its conviction that the goal of pollution abatement is to protect and enhance the capacity of the water resource to serve the widest possible range of human needs, and that this goal can be approached only by accepting the positive policy of keeping waters as clean as possible, as opposed to the negative policy of attempting to use the full capacity of water for waste assimilation.

You will note that there are certain significant differences between the comments of Panel I and Panel III. It has been suggested to me by a member of Panel III, who was not present last night at our subcommittee meeting, that the proposal be made that the suggestion of Panel I, which I just finished reading, be substituted for that which we agreed upon last night. I am presenting this proposal to you in the hope that you will consider it, for two reasons: (1) It is more positive rather than negative in relation to the Panel III observation; and (2) There might be some values, so some feel, in contradiction in language. But I am suggesting, on the part of the people proposing this, that they feel there might be some value in consistency in statement between the two panels.

I present it to you in the hope that you may show, not by vote, but by some expression, how you feel about the substitution.

**Mr. GUTERMUTH** (Natural Resources Council of America). As one of the members of the Steering Committee of Panel III that labored on into the night last night, and I do believe, Mr. Chairman, that this statement of Panel I is more positive than the statement which we adopted last evening. I recommend therefore, that we substitute the statement from Panel I.

**Mr. CANNON** (National Association of Manufacturers of the United States of America). I would like to call to the attention of the chair that Panel II also made a recommendation on the same subject. I made a comment on the recommendation of Panel II for an amendment to include the concept of economic feasibility which the chairman indicated had merit. Therefore, before any action is taken on Mr. Gutermuth's suggestion, I would like to offer the same amendment for consideration by those present here.

**Dr. WOLMAN.** Do you have a specific suggestion as to the modification or the substitution? This is a language problem and I don't want to get lost in it.

**Mr. CANNON.** My suggestion would be "As clean as economically feasible."

**Mr. GREGG** (Izaak Walton League of America, Inc.). I think the point that is raised by Mr. Cannon is valid. A qualification is necessary. We don't need to confine ourselves to considerations of economic values, although that is important, and perhaps the purpose could be served by saying "In keeping waters as clean as possible in consideration of health, recreation and esthetic values, and economic and technical considerations," or "Economic and technical possibilities," or something like that.

**Dr. WOLMAN.** May I try to resolve this, because if we get enough editorial suggestions from the floor, we will not get a panel statement. I would ask that the members of our own subcommittee on Panel III indicate on the cards that they may have available, which we will collect, as to what their general feeling is about the substitution. Also, I would ask the other speakers who have just suggested modifications in language that they submit to us here on the platform in the next 20 minutes or so what their modification is. I will defer this No. 1 statement until I have both sets of views in front of me, and then submit it to the Conference.

I hope that is agreeable to the group. Unless I hear some dissent, I shall proceed with item 2, hoping that you can register your judgments and any change in language to which I can return later.

2. Administration of water pollution control programs on State and interstate streams should continue to be the responsibility of the State agencies which therefore must be supported by adequate budgets and

staffed by competent directors, engineers, scientists, and related professional personnel. It is essential that State legislatures appraise more realistically their opportunities and responsibilities in carrying out the principle herein stated and are urged to take appropriate action where necessary.

3. The Federal Government has clear responsibilities in its working relationship with State and local governments with respect to: Research, leadership in personnel training, regulatory procedures, water resources inventories and investigations, and standards of water quality.

No agreement was reached among the conferees as to the extension of authority of the Federal Government in the area of water pollution control.

4. The Federal grants-in-aid program has provided a valuable stimulus to the control of stream pollution. Other methods of financing construction of sewage and waste treatment works deserve thorough study and investigation to determine the most appropriate means available or which might be made available for sound and equitable allocation of costs. Several other means of financing were suggested in one or two papers presented at the Conference. The view of the panel subcommittee was that these should be listed and appraised without any commitment on the part of the subcommittee as to which, if any, should be recommended. It did suggest that these and others unnamed should be explored at some subsequent time.

(*a*) Incentive grants from Federal and State appropriations;

(*b*) Guaranteed bonds;

(*c*) Revenue bonds;

(*d*) Marketing long-term revenue bonds under a Federal system of guarantees such as FHA-guaranteed mortgages or loans for defense production purposes;

(*e*) The creation of a "Water RFC" or such Federal finance agency to discount, purchase or collateralize such bonds for loan purposes; and

(*f*) The earmarking of specific taxes, notably, from Federal licensing of pleasure boats and sale of fuel to all waterborne craft, for water pollution control purposes.

5. The panel agreed that State statutes and organizational structures for water pollution control should be reviewed and strengthened or revised where necessary. The following revisions were proposed in the suggested 1950 State Water Pollution Control Act as a guide for State legislation in this field. The proposals were: (a) Vest comprehensive authority in the State water pollution control agency, which would be given independent status in its organizational placement in State government; (*b*) insure construction of municipal treatment facilities ordered by the State agency by authorizing courts to

direct all necessary steps, including bond issues, tax levies, and revenue charges, if required; (c) authorize the establishment of sanitary districts to deal with local pollution control problems beyond municipal limits.

The panel did not arrive at an agreement on these proposals.

6. There was general agreement that the public needs more information on pollution and its abatement. Government agencies and other informed individuals should make every effort to present the facts in understandable form for use by individuals, organizations, and the general media of communication. Such material should include factual information and suggested methods of attack as have been discussed by the conference.

**Mr. GUTERMUTH.** I am reporting, Dr. Wolman, that five or six members of your subcommittee got together to discuss the possible changes to this language of the statement from panel I which we had up for substitution for our first statement. We realize we are never going to get agreement on this in a meeting of this kind. So your panel recommends that we proceed with the original proposal, to substitute the statement from Panel I as written for our recommendation No. 1.

**Dr. WOLMAN.** Have you considered the suggested language made by various representatives?

**Mr. GUTERMUTH.** Yes. They feel, while it isn't explicity spelled out in this statement, everyone realizes and appreciates that the economic factors must be considered. It is assumed.

**Dr. WOLMAN.** I shall increase my unpopularity by assuming that this means you adopt Panel I's statement. Again I say that there shall appear in the record any disagreements or suggestions for expanded language, which would take care of those of you who feel that even though it may be implied, the language might be strengthened in the direction of economic use and application.

NOTE.—The recommendation agreed to is as follows: "We recommend that the Conference express its conviction that the goal of pollution abatement is to protect and enhance the capacity of the water resource to serve the widest possible range of human needs, and that this goal can be approached only by accepting the positive policy of keeping waters as clean as possible, as opposed to the negative policy of attempting to use the full capacity of water for waste assimilation."

The members of the Panel III Subcommittee, in addition to the Chairman were: Co-Chairman, Milton P. Adams, Michigan State Water Resources Commission; Robert F. Boger, Publisher, Engineering News-Record; Lloyd E. Partain, National Association of Manufacturers; Edward J. Cleary, Ohio River Valley Water Sanitation Commission; Harry Cornell, International Association of Game, Fish, and Conservation Commissioners; George H. Taylor, AFL–CIO;

Justus H. Fugate, American Municipal Association; C. R. Gutermuth, Natural Resources Council of America; David B. Lee, Conference of State Sanitary Engineers; John S. Samson, Nebraska State Water Pollution Control Council; J. V. Whitfield, North Carolina Department of Water Resources; and Mrs. A. E. Whittemore, League of Women Voters of the United States. The subcommittee was assisted by these PHS Resource Personnel: J. T. Barnhill, J. J. Flannery, D. H. Howells, and Murray Stein.

## GENERAL DISCUSSION

### Panel III Report

**Mr. SAMSON.** Gentlemen, we next come to that part of the program which is referred to as the open forum discussion, and I have been advised here this afternoon and in various parts of the building that there are some gentlemen who would like to be heard and like to express themselves. I want to say to you here and now that this is a democratic gathering and certainly I would be the last man in the world to say that we shouldn't have a full, complete, and honest expression. I am thoroughtly in favor of that approach.

The Chair now recognizes Mr. Edward R. Thornton, chairman, New England Interstate Compact Commission. Mr. Thornton.

**Mr. THORNTON** (Chairman, New England Interstate Compact Commission). Thank you, Mr. Chairman.

Ladies and Gentlemen: As a Democrat from New Hampshire, I always feel better if most of the people are in front of me rather than in back of me, so if you don't mind, I would like to turn a little bit.

I would like to address myself to Recommendation No. 3, relative to the extension of the authority of the Federal Government in the area of water pollution control. Speaking for the New Hampshire Water Pollution Commission, of which I am a member and for the New England Water Pollution Control Commission, we have no argument with the first paragraph of those findings. We wish to clear the record, however, in connection with the second part of those findings, which states, if my notes are correct: "No agreement was reached among the conferees as to extension of authority of the Federal Government in the area of water pollution control."

The reason that no agreement was reached yesterday, gentlemen, at this panel discussion, was because of the fact, that the chair ruled that there could be no vote taken, no resolutions passed by that panel. Due to the extension of the remarks and the time taken up by everyone, many of us were unable to have our questions answered. The number of questions answered by the panel were very, very few. I did present a resolution at that time to the effect that we wished to go on record as being opposed to any further extension of the Federal authority in the enforcement field. That resolution was taken under advisement by the subcommittee last night. It is my personal opinion that had a vote been taken yesterday afternoon, better than 80 percent present at that meeting would have agreed to that resolution.

I would like to make it clear that we in New Hampshire and in New England have no argument and no quarrel with the present Federal water pollution control law. We in New England have no quarrel or argument with the staff people of the Federal agencies who are assigned to our meetings and to our area. We get along with them. We have the highest cooperation. We admire and respect the gentlemen and the way they operate. We have no problems in New England that require or call for any additional activity by the Federal Government. As a matter of fact, we have not been impelled to call upon the Federal Government in any of the seven signatory States to the New England Compact. We feel very definitely that enforcement of pollution abatement is the primary responsibility of the State, and we further believe that existing laws at the Federal level and at the interstate compact level are adequate for present needs, and, therefore, we oppose the expansion or extension of Federal enforcement provisions to waters within the borders of our States.

Mr. Chairman, I appreciate that there is no possibility of a vote or a resolution of this group, but many of us have been here for 3 days. We haven't had an opportunity to express our opinion in any form on this matter and I would appreciate, sir, your permission to ask for an expression of opinion from this group as to how they feel on this question of extension of Federal enforcement authority. I would request, sir, that as many as are in favor of my philosophy, as enunciated by my few remarks, be allowed to show their approval of this philosophy by standing for just a moment. Is that possible?

**Dr. WOLMAN.** I rule that it is possible. We do not want to vote. The reason I make the ruling is that it is possible that there is evidently a great deal of feeling, I think to some extent unwarranted, but that is a private opinion, that industry is being made the goat in some of these discussions; that it has not had as much of an opportunity to make its comments, such as it would like; and that certain groups, such as you represent, did not have the opportunity *in extenso* of recording their judgments.

If you would repeat, I hope in the form of one sentence, what you would like to express your opinion in respect to, I should ask those to rise who happen to share your view, and have this recorded in the minutes of the Conference.

**Mr. THORNTON.** I request, sir, that those who feel that existing laws at the Federal level are adequate for present needs, and, therefore, are in opposition to the expansion or extension of Federal enforcement provisions to intrastate waters be allowed to signify their approval by standing.

**Dr. WOLMAN.** Is the audience familiar with what we are permitting them to do? Those of you who concur in this brief statement of judgment, will you please rise?

If they turned off the kleig lights, someone up here could register the fact that at least a very large proportion of the people here would share that view.

**Mr. THORNTON.** Thank you, sir.

**Dr. WOLMAN.** I shall now proceed with additional questions or comments. We are, in fact, bewildered by the number of questions that are here and I am not altogether sure how to make these choices. There are a number of people who have indicated to Mr. Samson that they want to make statements; without discrimination, let me call on them quite independently of alphabetical order or the like.

**Mr. THORNTON.** Some of those who are opposed to my philosophy have asked why they weren't given an opportunity to be recorded. I forgot to do that.

**A DELEGATE.** I don't think the people opposed are asking for that opportunity.

**Dr. WOLMAN** I rather assumed by those sitting down and who didn't get up, there was some comparison. I don't want to play favorites. Will those in the audience who do not share that philosophy please stand?

(There were members in the audience who stood.)

**Dr. WOLMAN.** It has been so done.

We have several requests for a comment from the floor. I ask Mr. Cornell if he will make his comments. Do you still desire to make a comment? I will restrict everyone to approximately a minute and a half. I do want to give as wide a spread and recognize as many as I can.

**Mr. CORNELL.** Thank you very much, Mr. Chairman.

It is my privilege to be here today representing the International Association of Game, Fish, and Conservation Commissioners. This Association represents, internationally, the administrators who are responsible for the management of our fish and game resources. At its annual meeting last September, there were two resolutions passed by our organization concerning this Conference and its results. I wish to give you copies of those resolutions at this time in order that they may become a part of the record of the conference.

The position of the international is summed up in two concepts.

Clean water is more than a public health problem. The elimination of disease-causing organisms is not enough to meet the national needs. Water must be reused again and again for industry, for drinking, for agriculture, and for recreation. Each user must return it, on its path to the sea, in a condition suitable for any of these uses.

The second concept is that the elimination of pollution is the responsibility of all levels of government; municipal, State, and Federal. When anyone fails to accomplish its task, the next level must take over. Each level of government must have adequate laws to accomplish this end.

The financing of an adequate pollution control program is obvious in principle; it is only complicated in detail. Industry must remove its wastes from effluent water and add the cost to the price of its product. The removal of human wastes from our waters must be financed by taxation. Individually and collectively our taxes must pay the price for usable water. It is reasonable that the three levels of government should contribute to pollution abatement.

This Conference may, or may not, accomplish its purpose of providing a blueprint for an adequate pollution abatement program for the next decade. Senators Kerr and Case, and Congressmen Blatnik and Cramer, in their presentations on Monday evening, however, made it abundantly clear that legislation for an improved pollution abatement program will be provided.

Dr. Gabrielson's paper on Monday indicated that our population consists of some 182 million people. Most of them are concerned with some form of recreation. He quoted a thorough study conducted in California which "showed that fully 60 percent of all recreation is water-oriented."

These figures, alone, should assure our legislators, at both the State and Federal levels, that clean water is demanded by the American people. So long as ballots determine the destiny of our country, legislation for clean water cannot fail.

**Dr. WOLMAN.** Thank you.

Mr. Hyslop asked to be heard this afternoon.

**Mr. HYSLOP.** I am James Hyslop, president of Hanna Coal Co. of Ohio and West Virginia. I am speaking here as a representative of the bituminous coal industry.

After observing the proceedings of this panel I wish to express my personal admiration and approval of the deep sincere concern for the welfare of humanity that has been so forcibly exhibited. One must respect and admire the spirit of dedication to a worthy, though ofttimes unpopular, cause that has been so evident in all who have actively participated. Such enthusiasm must surely lead to high and noble accomplishment. The coal industry feels that it can make a solid contribution to the objective for which the President of the United

States called this meeting by succinctly stating a few of its carefully considered views, as follows:

1. We respectfully suggest that the Conference give appropriate attention to the clearly indicated although inadequately emphasized fact, that important and highly significant progress has already been accomplished in the field of the abatement of stream pollution caused by industrial waste. We refer to the effective protection against pollution that has, at great expense, been built into most new plants that have been constructed in recent years, and to the improvements that have been applied by many older plants, that have vastly improved their performance.

2. It should be realized that the abatement program of industry is going forward at a very rapid pace. The job is by no means finished, but it is being pushed at a rapidly accelerating rate. Industry learns fast, its education in this field is being promoted by better State and local laws, more intelligent and vigorous enforcement of existing statutes, by public sentiment, by interstate compacts, and by its own enlightened self-interest.

3. Any new program that does not carefully and scientifically take these facts into account is going to be misguided by views which are badly out-of-date and unrealistic. Mistakes made as a result of the error will not only be wasteful of the public's money, but they will actually retard progress by introducing confusion and public disfavor. Emotion and fervor have their place in this cause, but they must be tempered by sanity and science. Industry is willing to accept intelligent criticism, it wants adequate credit for its accomplishments, and due recognition of the progress it is making.

4. The coal industry has made real and significant progress in pollution abatement, it is on record with State authorities and ORSANCO as not only favoring vigorous abatement programs and a diligent compliance with all regulations, but also has pledged itself to a program of research and cooperation designed to find solutions for the important unsolved problems that are peculiar to our industry.

5. All will agree that any unnecessary assumption of authority by Washington of powers that properly belong to the local governments is a grievous mistake. ORSANCO has done an outstanding job not only through solid accomplishments in cleaning up the waters of the Ohio River basin, but also in the difficult field of State, Interstate and Federal relationships in the abatement program. The success of this time-tested arrangement will surely be threatened by any Federal intervention into regulation and enforcement.

6. In view of these considerations and others, which, while important, could not be included in this limited statement, we

submit that any extension of Federal, legal or police authority in the field of stream pollution would at this time of accomplishment and progress be a serious and expensive mistake.

**Dr. WOLMAN.** There is a request of Mr. Erskin of the Izaak Walton League to be heard from the floor.

**Mr. ERSKIN.** If we are to maintain the dignity of our society and realize our objectives, we must go away from this most important meeting with moral obligation and with honest intentions to accept and activate the recommendations of this meeting.

I am sure we are all aware of the common law of averages. But as a Nation we have not been satisfied with the mere average of pure food, of education, of highways, or of other high standards we have learned to expect in our American way of life.

By the same token, we must expect and demand that our Nation's water be used with consideration for all segments of our society and maintained in a state of purity that will guarantee a continuing supply of clean water, and I will say "clean" twice.

**Dr. WOLMAN.** Mr. Billings would like to make a statement.

**Mr. BILLINGS.** I am R. M. Billings of Kimberly-Clark Corp., a member of the American pulp and paper industry. I have requested these few moments to set a matter straight for the record. We had supposed that the matter was common knowledge. However, certain reports read at the meeting by individuals who are not a part of industry have raised questions in our minds as to the completeness and accuracy of their information. Some seem to believe that industry does not recognize the problem of pollution. Nothing could be further from the truth, and I know, I speak for all industry.

Industry believes that we are in the midst of a serious pollution problem which will grow increasingly difficult to solve with each passing year, but industry believes that we will solve it and, what is more, industry knows that we are solving it now. What industry does not agree to is that the realization of the existence of the problem burst upon us December 12, 1960. We are not shattered by the revelation of the problem now; we have been sobered by the magnitude of it for the last 10 years—and we have been doing something about it. I would refer you to the curves giving production and water usage for the paper industry shown by Mr. Pasek yesterday. These indicate that over a period in which production has doubled in the paper industry, only nominal increases in water usage occurred. This amazing progress was brought about only by rapid expansion of research in the waste disposal field, and by constant attention to the problems.

New industrial plants constructed during the last 5 years have had waste treatment facilities incorporated as an integral part of their design of construction. Nearly all states already require this as a condition that must be met before a permit for construction and operation will be issued.

Yesterday's panels were punctuated with the loud reports of exploding populations. Industry has been hearing these reports even at first when they were very faint. Population increase means industrial activity increase. Industrial specialists have made carefully researched sales forecasts. Plans for expansion are already on the industrial drawing boards. But these plans without exception include adequate waste treatment facilities as an integral part. You just don't expand an old water-using plant or build a new one without giving as careful consideration to the quality specifications of the water leaving the plant as you do to the requirements of water coming to it.

In closing, I can proudly say that had all other water users of this nation made progress comparable to what American industry has made in the last decade and if all other water users had as well prepared plans as American industry has for the future, the problems confronting us now would be relatively small.

**Dr. WOLMAN.** Thank you.

In order to keep the pendulum swinging from one side to the other, I have a card here that points out this individual has a facetious remark which will be very short.

Do you mind giving us your name? And your affiliation?

**Mrs. DUNN.** My name is Annette Hoge Dunn, and I am from the New York State League of Women Voters.

I would like to point out that there are more industrialists present today than fish, and I am not including all industrialists.

**Dr. WOLMAN.** These rapier thrusts come from one side to the other and would be extremely interesting to a man from Mars, because perhaps he would want to remind those of us on earth that this is a curious kind of juxtaposition which we see here in the Conference, and in Panel III. Considering the fact that our country prides itself in being one of the great industrialized countries of the world, from which, incidentally, most of our satisfactions stem, I think it is worth including this velvet-glove statement, because I happen to feel it is true.

This is not done to reassure either the fish or the industrialists. One of the misfortunes that the fish have is that they can't talk back at us. But I do believe it is worth a sobering thought that the Conference should not give the impression in either direction that this is a simple battle between a set of disembodied citizens who are dispossessing the industrial growth of the United States.

It does occur to me that I might remind you of what I said yesterday, that this problem would be a simple one if we had no people in the United States. Nobody has had the temerity to get on the floor and suggest that as the overall solution. This sense of equilibrium is what I am trying to put in the record.

There are two questions here from P. J. Short, Jr., of Lukens Steel Co., neither of which is directed to me, but since he took the precaution of asking two questions, he gets a kind of preference, and I shall read one, and then the other, and perhaps give him my own impression, because it does fall, in a sense, within Panel III's comments.

On of the questions was directed to Mr. Boger and the other to Mr. Curley.

***"You referred to Federal taxes on our telephone bills and posed the possibility of taxing water utility bills. What agency do you have in mind to exercise this either on the Federal or the State level? Couldn't it be handled just as well on the local or State basis?"***

And the second question is: ***"Private industry is doing a real unpublicized job of waste disposal (as has been pointed out a moment ago) and has contributed substantially to the degree of pollution abatement. Would you care to elaborate on your reference to encouraging industry through tax benefits and any other compensations?"***

Neither one was directed to me, but I would like to comment. I call your attention to the fact that the panel items which deal with these subjects are very careful to suggest that all of those subjects should be reviewed in a much more thoughtful, much more logical, and much more detailed fashion than it was at all possible to carry out in this kind of a Conference.

I am sure that Mr. Short is even more aware than I am that any suggestion to give tax exemption to the Federal income tax for industry, for one purpose or another, is a long and combative and interesting battle. If he had hoped that even Mr. Curley or this Conference would have given him the simple and quick answer to this, I think he is much more naive than I know him to be. I merely remind him that all these considerations we felt needed scrutiny.

The simple one which Mr. Boger pointed out, taxing motorboats and the like, obviously is one which would require a tremendous amount of consideration. Our panel simply felt that these were ways of trying to find money. They all needed to be reviewed, discussed and battled through, I suspect, for a fair number of years to come.

Mr. Fugate, this is a question directed to you by R. N. Simonsen, of the Standard Oil Co. of Ohio: ***"In view of the dramatic success of ORSANCO in abatement pollution in the eight-State Ohio River Basin, do you still believe that Federal control is needed to control interstate pollution? If so, please comment."***

**Mr. FUGATE** (American Municipal Association). If every river basin had the leadership evidenced by the Ohio River Basin States, perhaps we of this Conference would not even be here. It is a pleasure for me to state that our city acquired by residence and by business affiliation one of the former members of the Advisory Board of this authority. I discussed this authority somewhat with him in the past several years. He is, shall we say, an enlightened industrialist. If we had an attack upon the problems on a river basin basis as has been done in the Ohio River Basin by every river basin authority and States and industries, we would need very little authority for the Federal Government.

**Dr. WOLMAN.** Are you willing, Mr. Fugate, to stand another question? The question is: ***"How do you reconcile your statement that you do not wish Federal control to be extended into every city and town with the program you outlined, giving the Public Health Service enforcement powers over navigable waters which, in itself, gives the Public Health Service power over every creek and also gives the Public Health Service complete control of State programs?"***

**Mr. FUGATE.** I want to point out to the proponent of this question the provision of the present Public Law 660. Eliminating some of the verbiage, it says here: "The pollution of interstate waters. Whether the matter causing or contributing to such pollution is discharged directly into such waters or reaches such waters after discharge into a tributary of such waters and which endangers the health and welfare shall be subject to abatement, as hereinafter provided."

I think that, if you study what waters are interstate waters and what waters are tributary to them, you will find yourself in need of some clarifying assistance, even as my city was when we considered building a water reservoir as a single-purpose project on a tributary of a navigable interstate stream. The attorneys for the city advised us that there was a question as to the authority of this one city to build this one reservoir on such a tributary without an act of Congress.

Next I want to say this, that with the problem of enforcement you get down to what is the most controversial and ultimately the most necessary part element to pollution abatement. You can talk about it, you can request cooperation, you can follow all of the provisions of the Blatnik bill, either as it exists or as it may be amended. Ultimately you get down in some instance to a situation such as St. Joseph, Mo. I say that if we are to take effective steps to abate pollution within the reasonable and foreseeable future, it must be implemented by adequate enforcement power by an authority which is sufficiently divorced from local influences so as to be effective within a reasonable time.

**Dr. WOLMAN.** I am now ready to accept either questions or comments from the floor for another 5 or 6 minutes, if there is a great urge on the part of anyone to comment. Does this mean exhaustion or agreement?

**Mr. ERSKINE.** Mr. Chairman, could I take two more seconds of your time? I would like to answer the lady about fish and industrialists. I happen to have some industrial dust on my feet, and I hope that our physical and financial ability in America will support both the fish and the industrialists.

**Dr. WOLMAN.** Senator Whitfield, of North Carolina.

**Senator WHITFIELD.** Ladies and gentlemen, we are closing this Conference shortly. I think we ought to realize, since this is the very first Conference of this kind in history, it is epic making. After all, why are we here? We are here to deal with people and their welfare. We are here to deal with the economic, social, and every type of welfare of the Nation.

I think we ought to be proud of the fact that this Conference has brought together so many people to discuss the problem and make it worth while, and let them see that the only way we can attain great things is to work at it. I want to thank everyone connected with it, and in particular the Public Health Service, for the arrangement of the program, as they have done. We all realize they are to be congratulated for this program and for this Conference.

After all, we have read a lot of fine speeches. We have a lot of facts. Then we get back home. We get back to the unspectacular. That is the part of water pollution that involves the cleaning-up process and making it possible for this Nation to continue its water supply.

We need 600 million gallons a day by 1980 our engineers tell us. Therefore we have to keep our streams clean if we are to take care of this need. I for one have enjoyed every minute of the Conference and I think it will be an epic-making Conference in the welfare and the history of this Nation.

**Dr. WOLMAN.** I have one more request for a comment from the floor by Mr. Moore.

**Mr. MOORE.** There is one point I would like to make. This is not a criticism. I think it is one that should be considered by all of us. Each of the groups or disciplines attending the Conference has been guilty of using exceptions to prove that something needs to be done. If we are to change our laws, or if we are to change the regulatory control on the basis of the exceptions, whether they be national or local, then we will be continually struggling to convince our legislatures, either at the State or Federal level, to adjust themselves to a new condition which perhaps will change tomorrow, because another set of people will be trying to work out their individual problems.

**Dr. WOLMAN.** I might add just this comment on that observation, that we were rather careful in the drafting of one of our recommendations in not suggesting that every State legislative structure and its organizational structure needed to be revised and be adjusted. We merely said that interested parties in each State might very well look at themselves and determine what they happen to need.

I think it is disconcerting to you, and perhaps also to me, that one of the papers on the panel, coming from Karl Mason, as you know, who is the chief engineer of a soverign State in which, incidentally, I believe a great deal of accomplishment has resulted over the years, is one of those who indicated that the States have been delinquent in their performance of their functions. I say disconcerting, and in some respects to me quite surprising, but that is what he feels.

Your comment, therefore, has some pertinence on this whole question.

I am going to close this session now since you can have your breathing spell before the more general and, I assume, more philosophical summaries which will take place.

May I take this opportunity as chairman of your Panel No. III of thanking the entire group for their remarkably fine participation and their even more remarkable patience with your chairman. Thank you.

(The following resolutions were submitted for the record by Mr. Harry Cornell, International Association of Game, Fish, and Conservation Commissioners:)

Whereas the Surgeon General of the United States Public Health Service, at the request of the President and the Secretary of Health, Education, and Welfare, has issued a formal call to a National Conference on Water Pollution to be held in Washington, D.C., December 12 through 14, 1960; and

Whereas a committee representing some 30 civic, scientific, and national organizations, including the International Association of Game, Fish, and Conservation Commissioners, has been working with the Public Health Service to plan and set up this Conference; and

Whereas this association recognizes the paramount importance of adequate supplies of clean waters in the maintenance of fish and game populations, as well as our human population; and

Whereas invitations to the Water Pollution Conference will include, among others, the fish and game commissioners of our 50 States: Now, therefore, be it

*Resolved*, That the International Association of Game, Fish, and Conservation Commissioners commends the Secretary of Health, Education, and Welfare and the Surgeon General of the United States Public Health Service for the initiation and vigorous prosecution of plans for a productive National Conference on Water Pollution; be it further

*Resolved*, That the association enjoins the Department of Health, Education, and Welfare, and the conferees, to accept the challenge of establishing high goals for a national pollution abatement program and to define practical methods for attaining those goals; and be it further

*Resolved*, That the association support the Conference, and urge its member organizations to attend and be prepared to offer constructive recommendations for necessary pollution abatement programs at National, State, and local levels.

Whereas, Public Law 660, passed by the 84th Congress in 1956, authorized Federal grants to stimulate the construction of needed municipal sewage treatment facilities; and

Whereas 4 years of operating experience under this act has clearly demonstrated that Federal grants have greatly stimulated such construction, and water pollution control problems are becoming more difficult, expecially in the fields of sewage, synthetic organic chemical and radioactive wastes; and

Whereas studies and surveys by State and Federal agencies clearly indicate the need for an accelerated program of construction to keep pace with burgeoning populations; and

Whereas the 86th Congress passed H.R. 3610, doubling the amount of Federal grants, and the President in vetoing H.R. 3610 stated that "recommendations" will be submitted to the Congress for strengthening the enforcement provisions of the Federal Water Pollution Control Act; and

Whereas the Secretary of Health, Education, and Welfare, Arthur S. Flemming, in response to President Eisenhower's directive, has announced a National Conference on Water Pollution in Washington, D.C., for December 12-14, 1960: Now, therefore, be it

*Resolved,* That the International Association of Game, Fish, and Conservation Commissioners urges Congress to enact legislation to—

1. Increase to $100 million the annual appropriation to assist in the construction of State-approved municipal waste treatment facilities; and

2. Strengthen the enforcement provisions of the Federal Water Pollution Control Act to abate pollution of our Nation's waters; and be it further

*Resolved,* That the International Association of Game, Fish, and Conservation Commissioners be fully represented at the National Conference on Water Pollution; and be it further

*Resolved,* That a copy of this resolution be forwarded to the President, the Director of the Budget, the Secretary of the Department of Health, Education, and Welfare, the Surgeon General, Members of the Congress, and the Governors of the respective States.

**Mr. SAMSON.** Ladies and gentlemen, it is now my pleasure to introduce to you and for your attention a gentleman who has done the tremendous job since yesterday of working out a summary of the Conference. The presentation of this work will be given to you for your thinking by Stuart Finley, of Washington, D.C.

# Summary Report

STUART FINLEY

***Documentary Film Producer, Washington, D.C.***

During this Conference you have received about 250,000 words of prepared text. They have been thrown at you in the individual panel sessions, and here in the main hall, plus three or four times that many extemporaneous words in the coffeeshops, corridors, and the men's room. When you get home, your associates, of course, are going to walk up to you and ask, "What happened?"

And I wonder how many of you have one succinct sentence that will describe what the lead story here is. I daresay that most of you haven't analyzed it that thoroughly yet, and the process of assimilation certainly is going to take a little longer than one day. It may take several weeks before it begins to sink in in true perspective.

As an interim device, permit me to summarize what I have seen and heard and read here. This report is a personal document and does not represent a policy declaration by our hosts, the Public Health Service, or anybody else. Actually, it is nothing more or less than a set of observations by an interested and nontechnical observer. And, incidentally, I hope it doesn't contain preconceived notions of any kind. However, in using what we might refer to as the "journalistic" approach, there will be probably many serious omissions and possibly a few distortions, but I hope not.

The measure of success of this Conference, as I see it, will be the degree to which what was said here permeates and influences your work in the coming years. I might add parenthetically, that the Air Pollution Conference of a couple of years ago was talky, inconclusive, nonspecific, and yet the many concrete activities of great value, stimulated by the public concern generated there, can be traced directly back to that meeting.

This Conference has developed 30 recommendations. Many of these were predictable in advance. This is the way of conferences on highly controversial subjects. Unanimous recommendations must be made on the virtue of motherhood and the evil of sin.

Actually, a Conference like this proceeds on at least two levels simultaneously. There is the conference of prepared papers and formal recommendations. And then there is the conference of side remarks, individual conversations, and even individual thoughts—thoughts of dissent or agreement, as the case may be. The first rarely parallels the second.

Another measure of the success of a Conference is the degree to which these private thoughts are aired, how much of the real controversy is brought to the surface, the extent to which each one is compelled to listen to the opposing viewpoint.

Let's summarize the Conference. As you came here, you expected unanimous consent that pollution is bad, and it materialized. Dr. Burney called it "a national disgrace."

Mr. Lynch, of the *Milwaukee Journal*, called it a "galloping national disease."

Mr. Fox, of Resources for the Future, Inc., put it realistically when he said, "The word 'pollution' connotes evil; therefore, it must be opposed."

But disagreement comes on this point. How bad is bad? How evil is evil? Or, as Mr. Gill put it, "How clean is clean?"

On this question there is a tremendous range of opinion, some of which was audible in quotations like these, for example:

Carl Brandt, a member of the President's Council of Economic Advisers, had this to say:

"While it may be deplorable that some fish are killed in a river or canal which actually served primarily as a carrier of industrial waste, it may yet be the case that this use of that particular current of water in a strictly industrial area may prove to be the highest marginal productivity attainable that far outweighs any potential value of the commercial or the sport value of the fish."

It was put another way by Leonard Pasek of the Kimberly-Clark Corp. He said:

"To a very substantial extent, American industry—and thereby our economy—has been built upon the base of that valuable economic asset, the ability of our great waterways to dilute, assimilate, and carry away industrial wastes. The result has been a living standard of widespread abundance and a national defense potential that has delivered the goods during three periods of military conflict."

You could, if you wished to be unkind, characterize these as "anti-antipollution" messages. But who wants to be unkind?

On the other side of the issue, Robert A. Forsythe, Assistant Secretary of Health, Education, and Welfare, had this to say:

"Many of the benefits from pollution control are in the nonmarket realm; for example, enhancement of fishing and recreational opportunities, protection to health, scenic improvement, and assurance of the future utility of water resources for various other purposes. The market system, therefore, cannot be relied upon solely or chiefly to identify or measure the benefits obtained by pollution control."

Your discussion panels wrestled with this divergence of opinion and came up with some very interesting language. On the subject of "How Clean is Clean?", Panel III said:

"The national goal with respect to stream protection should be the safeguarding of water quality. Every stream should be made to provide for the fullest range of uses for the type of society served, and consistent with the variabilities within and among different river basins."[1]

Note that phrase: "For the type of society served." What type of a society do you want?

Panel II put it more strongly and in different terms:

"We recommend the adoption of a national credo, to be given as wide and consistent publicity as is feasible. The content of the credo would be:

"(1) Users of water do not have an inherent right to pollute; (2) users of public waters have a responsibility for returning them as nearly as clean as is technically possible; and (3) prevention is just as important as control of pollution."

Panel I came up with another, even more positive synthesis:[1] "We recommend that the Conference express its conviction that the goal of pollution abatement is to protect and enhance the capacity of the water resource to serve the widest possible range of human needs, and that this goal can be approached only by accepting the positive policy of keeping waters as clean as possible, as opposed to the negative policy of attempting to use the full capacity of water for waste assimilation."

In sum, then, it would seem that we must amend our first area of agreement somewhat. The National Conference on Water Pollution is not unanimously against all pollution. But the accent should be on the positive—keep streams as clean as possible, rather than working them to death digesting wastes.

The next question is: "How well are we doing?" Another great range of opinion, and we will cite a couple of examples:

Dr. Ira Gabrielson, of the Wildlife Management Institute, had this to say:

"Reports that analyze water supply and demand are in general agreement that little progress is being made in preventing the contamination of ground and surface waters. Case histories are cited for most parts of the country. Corrective action is not keeping pace with the problem. We are failing to improve and protect water supplies from the polluting effects of materials and conditions that we already have the technology to combat. Comparatively little is known about the new pollutants which are adding to the problem daily."

---

[1] The wording of this recommendation was changed to agree with the recommendation of Panel I.

On the other hand, Leonard Pasek said:

"At least three decades ago industrialists began to exert strong efforts to minimize the necessary workload on these waterways. Since that time, great strides have been made in industry's progress toward solution of industrial wastes problems and toward the financing and constructing of the facilities to implement these solutions.

"Thus, there is every indication of a marked increase in conservation of water by industry."

Mr. Forster, of the Hercules Powder Co., stated the case for industry in these terms:

"In the last few decades, I submit that industry for the most part has not only assumed its responsibility in the conservation and safekeeping of water supplies, but has done so at a faster rate than many municipalities so anxious and eager to have industry as a neighbor."

Now, it may have slipped past me, but I didn't come across any comparable claim for the virtue of the Nation's municipalities, and yet the statistics cited on new municipal construction, by Dr. Burney and others, are fairly impressive.

It would seem that each Conference member's answer to "How well are we doing?" depends on his answer to "How clean is clean?"

I think it wouldn't be overstating the case to say that this is the consensus of this Conference (no doubt, with some dissenters); that we are not doing well enough. Municipalities are not doing well enough, and industries are not doing well enough.

But when you hear Mr. Forster quote a figure of $100 million spent last year by the chemical industry alone in pollution-control works, which, incidentally, bring in no profits in terms of stock dividends, it makes you stop and think.

Now we ask, "Where do we go from here?"

On this question there were substantial areas of agreement.

First, there was virtually unanimous approval for more research. Two predominant areas of research needs are health effects and engineering.

In the area of health, Dr. John Zapp, of the Du Pont Co., stated the new challenge in these terms:

"This is a different kind of question about wholesomeness than that which has been asked heretofore. We know that the ingestion of these waters produces no immediate harmful effects. But what of the long run? What about 20 or 30 years from now? Will the continued ingestion of these waters over the years lead to some cumulative effects which eventually produce disaster? The horizon of our concern has been pushed further into the future in these last decades."

Numerous speakers pinpointed specific questions: The problem of lead, which we ingest through water, air, food; the problem of radioactive wastes and their safe disposal; the problem of virtually indestructible viruses; the problem of detergents and other synthetics.

Professor Eliassen, of MIT, commented:

"Many of the newer synthetic chemicals, the so-called exotic chemicals * * * are not subject to bacterial degradation when present in solution in municipal and industrial waste waters. Thus they pass unchanged through treatment plants to watercourses and unchanged through water treatment plants to consumers."

And so it goes on, and on. No end of research questions to be investigated, and to be resolved, all of them related to human health.

Now, in the second area of research, that of engineering research, there are challenges innumerable. Some of them might save some money, too. It has been suggested that new and radically different treatment methods may hold the eventual answers.

On the subject of responsibility for research, Panel II came forth with a strong statement which I think bears repeating:

"It should be regarded as an obligation on the part of industry to undertake basic research which will determine the biotic and other effects influencing the public welfare of the products they distribute. Where the effects of these or other health hazards or potential public nuisances are not adequately treated within industry, the Federal Government or the States must provide for and budget such research."

Nor were all of the research challenges limited to the strictly scientific and technical fields. Panel I indicated a need for "a more systematic approach to the evaluation of the water pollution problems, to include health, esthetic, and market values. A framework for analysis must be developed which will provide a relatively precise understanding of benefit-cost and which will form the basis for the design of public policies and programs for effective water quality management.

Another area of total agreement echoing through all the panel sessions was the need for more and better basic data. In brief, we need more facts—facts on what is going into our waters, facts on what damage these things do, facts on how to eliminate these harmful pollutants, facts on what it will cost if we do and what it will cost if we don't.

All of these recommendations were predictable in advance, but there will have been great value in restating them if, in the days ahead, there is an accelerated effort to get these jobs done.

It was observed in Panel IV that more trained personnel are urgently needed in the many fields related to water pollution control. It was widely lamented that sanitary engineering has not been keeping pace with other scientific and engineering disciplines in the race for top-quality young people taking advanced degrees. It was strongly recommended that all the interested groups take action to correct these deficiencies.

It was further agreed that there is a continuing need for public information. Mr. Lynch, whom I have quoted before, put it this way:

"What is needed is a public sense of urgency. As for citizen responsibility, that is just a fine-sounding expression. In the broad sense, I think, it never really exists except in terms of emergency, and then it is not truly responsibility, but fear, anger, or outrage. Do you think that the citizens of St. Joseph, Mo., recognized any responsibility when they voted down sewage plant bonds last spring? Certainly they were aware that their sewage was going down the Missouri River, creating problems for other communities."

Speaking personally, as a citizen already aroused and as one who is in the the business of creating a sense of public urgency, I speak very feelingly on this point.

The ratio of interested citizens to disinterested citizens is still very small. What is needed here is more than a pious recommendation; what is needed is ammunition.

We need more research, more basic data, more trained personnel, more public information. On this we all agree.

So now, let's get down to the guts of the most controversial of all problems of water pollution, the simple problem which can be summarized by the brief question: Who is in charge?

Now, perhaps on Monday night you will remember Congressman Cramer was giving his speech and in the middle of his speech there was applause. Up until then there had been no applause except at the end of a talk. I looked around the room as did you. Half of the people were applauding. The other half were not applauding. However, the other half had been applauding when John Blatnik spoke a little earlier at the conclusion of his speech.

So I point up the controversy to you so that you can face it a little better. Controversies are no fun if you don't face them.

Congressman Cramer proposed these amendments to the law:

1. To strengthen State and interstate water pollution control programs.
2. To make more effective assistance to municipalities in the construction of necessary sewage treatment works.
3. To provide for more effective prevention and control of water pollution caused by Federal Government installations.
4. To strengthen the role of the Federal Government in abating pollution of interstate waters.

Mr. Blatnik had four points in his proposed amendment to the legislation. He said that he would call for—

1. Greater Federal research.
2. Expanded Federal enforcement jurisdiction over all navigable waters.

3. Stepped-up Federal aid to communities for construction of waste treatment plants.

4. The establishment of an independent agency in the Department of Health, Education, and Welfare to handle Federal water pollution programs and activities.

Areas of overlap, but utter and complete disagreement of philosophy, no matter how you look at it. Who is right?

Even panelists, who were not Congressmen and were not politicians, became involved in this complete difference of philosophy. Listen to these two quotes:

First: "If this problem were strictly a local one, as claimed by some, then it might be reasonable to expect local government to come up with the solution. It is true that the problem is frequently a local one, but is not always a local one. Moreover, some of these situations are so complex that no reasonable combination of local and/or regional authorities can handle them. I am inclined to believe that if the Federal Government does not provide the stimulus and the push for correcting our pollution situation, then we are left with the world's greatest buck-passing game of the pot calling the kettle black, of each community claiming its neighbor is to blame."

Another speaker on the same panel on the same day concluded his remarks this way. He said:

"Historians have noted that over the centuries oriental despotism has been associated with centralized control of water resources. Unless it is the decision of the American people to alter our economic system and abandon our private enterprise approach, the only progress that can be made by private economic units will be the result of having control and application of solutions at local or regional levels in order to maintain the flexibility necessitated by the fact that different conditions surround every problem of wise use of water resources."

Between these two extremes, and probably combining many others, lies the solution of the water pollution problem in the United States today. It isn't surprising and it certainly shouldn't be disappointing that this Conference was unable to discover a formula to answer these questions: Who's in charge? And of what? It is not surprising that Panel III, which was wrestling with these most fundamental of all questions, was forced to report:

"No agreement was reached among the conferees as to extension of authority of the Federal Government in the area of water pollution control."

Now, in my admittedly personal and inexpert view, the fact that these vigorously opposed positions were brought into the open, in the spotlight that accompanies a national conference, is of great significance in itself.

Further, any recommendations which this Conference might have reached, through some incredible feat of magic, would necessarily be tentative. This is a political fact of life at the beginning of a new Administration. It is an economic fact of life in a society in which the equations are constantly changing, being rebalanced.

Mark Hollis said, on the first day, that some of the interests represented here "have long been known to coexist with something less than brotherly love." He followed this masterful understatement with the hope that this Conference might "stimulate something beyond a cool air of coexistence * * * point the way to a common understanding and a unified approach."

I have the impression that this has been done. I have the impression that, although the "unified approach" has not been defined, the way has definitely been illuminated.

You stand agreed that the control of water pollution is a matter of vast and urgent concern.

You stand agreed that the Federal Government, interstate agencies, municipalities, industries, and the general public must augment their present efforts, separately and jointly.

You stand agreed, I think, that there is work enough for all, and glory enough for all.

As you go back to your jobs, I hope it will be with a sense of urgency, and perhaps with a desire to change the question "Who's in charge?" to "How can we work together?" I thank you.

# Federal Role in Pollution Control

HON. ARTHUR S. FLEMMING

***Secretary of Health, Education, and Welfare***

Dr. Burney and members of the Conference, I am certainly very happy to have the opportunity of participating in this closing session of the first National Conference on Water Pollution. I am delighted that through this Conference those who are interested in the advancement of fundamental and practical knowledge in this area and those who are interested in promoting action programs have had the opportunity of getting together under the auspices of the U.S. Government.

Ever since the President asked me to arrange for such a Conference, I have followed with great interest the plans that have been developed. From the beginning I stated that I hoped that this Conference would frankly identify the issues that confront us in this area; would frankly discuss these issues; and that all points of view would have the opportunity of being represented, and then would finally make recommendations that would serve as a guide to all of us who are interested in getting solutions to the problems that confront us in this area.

You are in a far better position to indicate than I am whether or not these objectives have been achieved. I certainly hope they have been.

As a result of this short, but intensive, education that I have had in this area over the period of the last 2½ years, I am convinced that action on many fronts, in order to deal with this problem of water pollution, is one of our Nation's most pressing needs. I am sure that it is obvious to everyone here this afternoon that I have only 36 days to give consideration as Secretary of Health, Education, and Welfare to the recommendations made by this Conference. I guess by now it is just about 36 days that I have left. I can assure you, however, that I will take the recommendations from this Conference, will give particular consideration to those that are addressed to the Federal Government and, if it is possible for me to take additional action during the remaining 36 days, in order to strengthen the role of the Federal Government in this area, I will do so.

But, in addition, I believe that, as a result of the high privilege that I have had of serving in my present office, I will have an obligation as a private citizen to do everything I can to support and to encourage and urge support for programs that are designed to strengthen the role of the Federal Government in this area.

In this closing address, therefore, I am going to identify the steps that, if taken, will, in my judgment, enable the Federal Government to play the role it should play in dealing with this major national problem.

Before, however, identifying some of the things that I believe should be done, I want to speak, first of all, about something that I believe should not be done. I refer to the proposal that some have made to transfer responsibility for the Federal Government's program in the water pollution area from the U.S. Public Health Service. I believe that such a move would result in progress in this direction being retarded rather than being accelerated.

Here are my reasons for arriving at this conclusion:

The Public Health Service, over the years, has recruited and trained for service in this area a group of unusually competent and dedicated public servants.

In the second place, the work of these men in the water pollution area has been integrated with the total program and resources of the Public Health Service in such a manner as to enable them to draw on resources that could not possibly be duplicated at any other point in the Government. And I make that statement advisedly, drawing on the experiences that I have had serving as a member of both Hoover Commissions on the Reorganization of the Executive Branch of the Government, and also serving for the last eight years as a member of President Eisenhower's Committee on Government Organization.

My third reason for feeling that this would be an unwise move is this: I have discovered that the men who have risen to top leadership in the Public Health Service recognize they are crusading for clean streams and that this is one of their major responsibilities. This is reflected in the way in which they press, both within the executive branch and on Capitol Hill, for additional resources to enable them to discharge this responsibility more effectively.

My fourth reason for feeling that this would be an unwise move is this: The career civil servant who plays such an important role in the conduct of all of the programs for which the Department of Health, Education, and Welfare has responsibility likewise recognizes that the water pollution area provides the Department with a unique opportunity for constructive service. This recognition is likewise reflected by the way in which they press for additional resources for the conduct of programs in this area.

May I point to the fact that this leadership that comes from the Public Health Service and that comes from our career civil servants in the Department produces results. In 1954 the total amount of money available for work in the water pollution control area in the Public Health Service was $1,063,000. The operating budget this year for all activities, exclusive, of course, of the research grants for the construction of waste disposal plants is $12,142,000, and I am confident that the budget that will be presented to the Congress by the President in January will call for further substantial increases.

Finally, there is no question in my mind but that those who are placed in top political positions in the Department of Health, Education, and Welfare will propose and support programs of action in this area.

I believe that by placing this responsibility in the Department, and specifically in the Public Health Service, substantial progress has been made. There is no question in my mind but that additional progress will be made, and I am confident that a move to pull it out of the Public Health Service would retard rather than accelerate this progress.

Now, having indicated to you one thing that I think should not be done, I want to identify those things that, personally, I am going to work for in an effort to make the Federal Government a more effective partner with States, municipalities, and private organizations in the crusade to clean up the streams of the Nation. First of all, I believe that the Federal Government should continue to make available additional resources to the Public Health Service for the collection and dissemination of data, of information. The Federal Government's opportunity for leadership in the water pollution control field is virtually unbounded. This leadership will rest on a solid foundation only if the Public Health Service is provided with the resources that it must have in order to bring together the facts on which action by government at all levels, by private industry, and by private groups can be based.

In the second place, I believe that the Federal Government should continue to make available additional resources for the conduct of research programs by its own personnel and for making grants for research and training projects and demonstrations to public and private agencies.

The investment that has been made to date in this area, it seems to me, has produced very significant results. It is obviously impossible to develop sound action programs to deal with many of the problems in this area, because we have not yet, through research, identified the type of action program that will produce results. It is clear, therefore, that unless the Federal Government does increase its investment in the research area, we are being penny-wise and pound-foolish.

In the third place, I believe that the Federal Government can very appropriately make additional resources available for giving technical assistance to State and interstate agencies. In transmitting a communication to the Congress last spring dealing with issues in the water pollution control area, I included in the communication this statement:

"With the improved State programs that have been strengthened by Federal program grants, it has been possible for the Public Health Service to put more of its resources into the larger problems requiring assistance."

This statement, it seems to me, points up the fact that, if we are willing to do more than just pay lip service to the idea of State participation in these programs, we are able to get results. I believe, as I know many of you do, that the States must play an increasingly important role in this area. I believe that it will be possible for them to do so if the Federal Government is willing to give technical assistance.

In the fourth place, I believe that the authority which expires on June 30, 1961, to make grants to State and interstate agencies to assist them in meeting costs of establishing and maintaining adequate water pollution prevention and control programs, should be extended for at least another five years. In fact, I would see no reason at all why it should not be extended for an indefinite period of time. And furthermore, I believe that the annual appropriation authorization should be increased from $3 million to at least $5 million.

Here again the Federal Government is provided with the opportunity of stimulating action at the State and interstate level, which, if stimulated, will foreclose the necessity of the Federal Government becoming involved in the direct operating programs in this area.

Fifth, I believe that the program under which the Federal Government has made grants available to localities to pay part of the cost of constructing municipal sewage treatment works, has been a very successful program and should be continued. I am impressed with the fact, as are many others, that during the period that this program has been operating, for every Federal dollar that has been spent, our municipalities have spent almost five dollars.

It is no longer necessary for us to speculate whether the Federal Government can stimulate increased investment on the part of local governments in this program. We know that it can. Personally, therefore, I can and will support the continuation of this program in the conviction that it is making a major contribution to the achievement of the objective that I believe this Nation must achieve. It is a sound investment of Federal dollars.

In the sixth place, I believe that there should be an expansion of the activities of the Public Health Service in the area of developing comprehensive plans for water pollution control by major water drainage areas. These plans must, of course, be developed in cooperation with State and interstate agencies, municipalities and industry. Surely, however, it is clear to all of us that we cannot expect to have sound action programs unless proposed programs can be related to comprehensive water pollution control plans.

In the seventh place, I firmly believe in the role of the interstate compact in dealing with this problem. I believe that the Federal Government should continue to encourage and to lend assistance to the development of these compacts.

In the eighth place, I believe that steps should be taken to provide for more effective prevention and control of water pollution caused by Federal installations. A step can be taken in this direction by amending the enforcement section of the Water Pollution Control Act, so as to provide that findings and recommendations of the hearing boards set up under the act shall include specific recommendations relative to discharges from Federal property which are contributing to pollution.

And finally, I believe that the role of the Federal Government in abating pollution of interstate waters should be strengthened. The enforcement procedures now included in the Water Pollution Control Act provide a mechanism for bringing into play the combined strength of State water pollution control agencies, the interstate agencies, and the Federal Government. This is as it should be. This must be a partnership endeavor. These procedures, however, are now authorized only for cases of pollution which are damaging to health or welfare of persons in a State other than a State of origin. I believe that these procedures should be made available also whenever there is pollution affecting legitimate uses of the waters of any navigable interstate stream, whether or not there is interstate pollution. Federal jurisdiction in this kind of pollution, however, should be exercised only upon request by the State, and then only when the interference with legitimate uses is judged to be of sufficient significance to require the initiation of enforcement procedures.

I also believe that the Water Pollution Control Act should provide a mechanism for the initiation of enforcement procedures by a municipality adversely affected by water pollution. Likewise, however, I believe that this avenue for remedial action should be limited to situations in which the Federal Government or State water pollution control agency has concurred in the municipality's request.

Likewise, on the basis of the experience that I have had with this enforcement section, I believe the Congress should clarify and strengthen the role of the Secretary of this Department in the enforcement processes, by providing that the findings and recommendations of the hearing board shall be the Secretary's findings and recommendations, except to the extent modified by him, and providing for issuance of an order instead of a notice by him for abatement of any pollution found to exist. Parties of interest should be provided with the opportunity of appealing the order of the Secretary to the United States Court of Appeals.

Finally, I believe that the definition of interstate waters in the Water Pollution Control Act should be amended so as to include all waters which flow across or form a part of State boundaries, coastal waters would be specifically included in this definition.

May I say to you that, as a result of the experiences that I have had within the Department, on Capitol Hill, with many of the organizations that are represented here, with the industries that are concerned with this problem and with many of you on a personal basis, I have been tremendously impressed by the team spirit that has been and will be displayed by all who are related to this major national problem. I do not think that there is really any argument over objectives. From time to time disputes do arise as to the factual situation that confronts us, and also as to the best methods to follow in order to achieve our objectives. But my experience with the enforcement provisions, particularly of the Water Pollution Control Act, convinces me that once a competent and respected body has provided interested parties with findings of fact and recommendations based on those facts, those interested parties are willing to go ahead and carry out the recommendations. As far as I can recall, there is not a single instance where an industrial concern has failed to move in the direction of complying with the recommendations of these hearing boards, and I certainly want to pay tribute to those industrial concerns for their willingness to act, and I believe that they reflect the spirit that prevails in industry generally.

Likewise governmental bodies have shown a willingness to comply with these recommendations. Of course, there is one exception to this generalization; namely, St. Joseph, Mo., which is now being followed up in the courts under the provisions of the Water Pollution Control Act.

But contrasted with this one situation is the fact, for example, that voters went to the polls in November and approved bond issues totaling over $100 million for the construction of facilities which are needed by the municipalities to carry out the recommendations of these hearing boards.

The response that we have received as a result of action taken under the enforcement section of the Water Pollution Control Act is, in my judgment, a reflection of an increasing determination on the part of the people of this Nation to clean up our streams as rapidly as possible. By your presence and by your participation in this Conference, you have made a major contribution to achievement of this objective.

I look foward to the opportunity of continuing to work with you. I will be working on the other side of the table. But I will be more than happy to do anything I possibly can to work with you in order to help achieve the kind of objectives, the kind of end results that I have outlined here this afternoon, and I am confident that because many persons, many groups will be working hand in hand with government at all levels, we can look forward to the future with optimism.

Significant results have been achieved up to now. I am sure, however, in the months and years which lie just ahead, with the results that will be achieved being far more significant than those that have been achieved up to the present time.

By coming here, participating in this Conference, you have served your Government and your Nation. And I sincerely hope that as you look back on this Conference three months from now, six months from now, a year, two years from now, you will be able to see and to identify substantial results growing out of your willingness to give of your time, energy, and resources.

Thanks a lot for all that you have done. Best wishes as far as the future is concerned, as we work together in order to achieve an objective that must be achieved by our Nation; namely, cleaning up the streams of our Nation. Thank you.

# Closing Remarks

Dr. Leroy E. Burney

***Surgeon General***

I think the comments of Secretary Flemming indicate once again the fine support he has continued to give to this activity.

I think, too, that we are fortunate he is ending this Conference with his challenging remarks, which are more telling now than they might have been at the beginning of the activity.

As we close this first National Conference on Water Pollution, may I express our gratitude to all of you for coming to this Conference and taking part in it. I think the people in our Nation owe a debt of gratitude to each of you for the sacrifices you have made and the counsel you have given.

May I join with Secretary Flemming and our Water Pollution Control Advisory Board in wishing you all a very safe journey home. I also wish to each of you and your families a very Merry Christmas and a pleasant and profitable New Year. Lastly, may I wish you success in your efforts to provide clean water to our States and to our Nation.

The first National Conference on Water Pollution is now adjourned.

# Recommendations of the Conference

## A Compilation of the Recommendations of the Conference from Panels I, II, III, and IV

1. That the Conference express its conviction that the goal of pollution abatement is to protect and enhance the capacity of the water resource to serve the widest possible range of human needs, and that this goal can be approached only by accepting the positive policy of keeping waters as clean as possible, as opposed to the negative policy of attempting to use the full capacity of water for waste assimilation.

2. The adoption of a national credo, to be given as wide and consistent publicity as is feasible. The content of the credo would be: (*a*) Users of water do not have an inherent right to pollute; (*b*) users of public waters have a responsibility for returning them as nearly clean as is technically possible; and (*c*) prevention is just as important as control of pollution.

3. There is need for a more systematic approach to the evaluation of the water pollution problems, to include health, esthetic, and market values. A framework for analysis must be developed which will provide a relatively precise understanding of benefit-cost and which will form the basis for the design of public policies and programs for effective water quality management.

4. Planning for the comprehensive development of each major basin or water resource area should be established as a fixed national policy. By comprehensive development we mean the application of integrated multiple-purpose design, planning and management which include the joint consideration of ground and surface waters, systematic conservation by water users, and the treatment and management

of waters having substandard quality. Consideration of every appropriate technique would be a routine part of planning for such development.

Such planning, insofar as feasible, should include consideration of all important industrial plant sites. An early and important objective should be a systematic program of flow regulation. State initiative toward comprehensive planning should be encouraged, and participation by all major interests should be encouraged. The objective should be one of eventually producing maximum total benefits from all economic and social uses.

5. Provision should be made, legally and financially, for the identification and acquisition at an early date of reservoir sites needed in the execution of comprehensive plans. The mounting population, the spread of settlement, and general intensification of valley land use otherwise may make many good sites totally unavailable or prohibitively costly.

6. The value of soil conservation, sediment control, and salinity control as pollution abatement measures should be recognized through planning and budget in our National, State, and local resource development programs. They should be considered as tools to be applied in water development and management. Pollution abatement is a problem with roots in rural land use and agronomy, as well as in urban congestion and industrial growth.

7. That public policy formally recognize the recreation value of our water resources as a full partner with domestic, industrial, and agricultural values in water quality management policies and programs.

8. Administration of water pollution control programs on State and interstate streams should continue to be the responsibility of the State agencies which therefore must be supported by adequate budgets and staffed by competent directors, engineers, scientists and related professional personnel. It is essential that State legislatures appraise more realistically their opportunities and responsibilities in carrying out the principle herein stated and are urged to take appropriate action where necessary.

9. The administrative level of the Water Supply and Water Pollution Control activities in the Public Health Service and in the States should be commensurate with the importance of this problem.

10. That State statutes and organizational structures for water pollution control should be reviewed and strengthened or revised where necessary. The following revisions were proposed in the suggested 1950 State Water Pollution Control Act as a guide for State legislation in this field. The proposals were:

(*a*) Vest comprehensive authority in the State water pollution control agency, which would be given independent status in its organizational placement in State government;

(*b*) Insure construction of municipal treatment facilities ordered by the State agency by authorizing courts to direct all necessary steps, including bond issues, tax levies, and revenue charges if required;

(*c*) Authorize the establishment of sanitary districts to deal with local pollution control problems beyond municipal limits.

Panel III did not arrive at an agreement on these proposals.

11. The Federal Government has clear responsibilities in its working relationship with State and local governments with respect to: research, leadership in personnel training, regulatory procedures, water resources inventories and investigations, and standards of water quality.

No agreement was reached among the conferees as to extension of authority of the Federal Government in the area of water pollution control.

12. That appropriate public and private agencies mount and sustain an expanded program of public information to the end that enlightened public opinion can be brought to bear on the accomplishments, costs, needs, opportunities, and problems involved in water quality management, noting that this Conference should provide a dramatic opportunity to launch such a program.

13. There was general agreement that the public needs more information on pollution and its abatement. Government agencies and other informed individuals should make every effort to present the facts in understandable form for use by individuals, organizations, and the general media of communication. Such material should include factual information and suggested methods of attack as have been discussed by the Conference.

14. The Federal grants-in-aid program has provided a valuable stimulus to the control of stream pollution. Other methods of financing construction of sewage and waste treatment works deserve thorough study and investigation to determine the most appropriate means available or which might be made available for sound and equitable allocation of costs. Several other means of financing were suggested in one or two papers presented at the Conference. The view of the Panel subcommittee was that these should be listed and appraised without any commitment on the part of the subcommittee as to which, if any, should be recommended. It did suggest that these and others unnamed should be explored at some subsequent time.

(*a*) Incentive grants from Federal and State appropriations;

(*b*) Guaranteed bonds;

(*c*) Revenue bonds;

(*d*) Marketing long-term revenue bonds under a Federal system of guarantees such as FHA-guaranteed mortgages or loans for defense production purposes;

(*e*) The creation of "Water RFC" or such Federal finance agency to discount, purchase or collateralize such bonds for loan purposes; and

(*f*) The earmarking of specific taxes, notably, from Federal licensing of pleasure boats and sale of fuel to all water-borne craft, for water pollution control purposes.

15. The construction of municipal waste treatment facilities should be expanded immediately with continued increases to keep up with population growth and to abate the backlog of pollution by 1970. A similar program expansion should be applied to the wastes from industry.

16. That financial incentive should be provided to encourage industry to install needed waste treatment facilities. This may be accomplished by permitting industry, for corporate income tax purposes, to charge the cost of nonproductive waste water treatment facilities as expense.

17. Each Federal installation should be required by Congress to treat its wastes in accordance with the standards for cities and industries in the area, with 1964 set as the target date for providing minimum treatment.

18. Enlargement and extension should be made of the water quality monitoring programs now in effect, so as to reveal more adequately conditions, existing and future, in rivers and streams. We believe that the protection of the public health and the preservation of water supply sources for accepted beneficial uses requires such extension and enlargement.

19. In order to facilitate assessment of the total pollution problem, it is recommended that particular attention be given to accelerating the collection of information on industrial waste loading. The Public Health Service should coordinate collection of this information on the national level.

20. States should develop water monitoring programs for bacteriological, biological, chemical, physical and radiological quality. This work should be coordinated with the efforts of an expanded National Water Quality Network of the Public Health Service. More data should be collected on the condition of streams both before and after water pollution abatement.

21. Provision should be made within the Public Health Service for developing the water quality criteria which are suited to application on a national basis. However, many water quality criteria are not uniformly applicable because of the effects of area usage differences, stream characteristics and other factors. State and local determinations of some criteria also will have to be made. It is recognized that periodic revision of these criteria not only will be in order, but should be sought, as new data are made available.

22. That the Public Health Service assume leadership, in collaboration with other public and private agencies, in collecting, compiling, and publishing pertinent data on the toxicity of water contaminants. This should include criteria, standards, methods of testing and safe allowable concentrations for human consumption; also that efforts be made to stimulate toxicological and epidemiological studies to be made to determine long and short-range effects.

23. The total national support for research in water supply and water pollution control should be increased substantially.

24. The flow of research findings on the water environment must be increased and intensified in depth as well as breadth.

25. That improved methods be developed for measuring pollution abatement progress. New engineering parameters which encompass all pollution components, as well as yardsticks for measurement of stream quality, are critically needed.

26. It should be regarded as an obligation on the part of industry to undertake basic research which will determine the biotic and other effects influencing the public welfare of the products they distribute. This should apply to detergents, insecticides, pesticides, herbicides, fertilizers and other microchemicals and microbiologicals, and to the effects of metallic wastes such as compounds of chromium and cyanide. Where the effects of these or other health hazards or potential public nuisances are not adequately treated within industry, the Federal Government or the States must provide for and budget such research. Additional research of peculiarly public responsibility includes the effect and interpretation of reducing anaerobes, nitrifying bacteria, viruses, protozoa, and other biota, and radiation hazards.

27. The flow of engineers and scientists who are competent to advance and administer the scientific, technological, and economic conservation of our water resources, including, in particular, the control of water pollution, must be increased promptly by recruitment and training of basically qualified personnel at two levels: (a) the professional or predoctorate level; and (b) the postdoctorate level.

28. The field of water supply and pollution control has become so complex that we must think more generally than in the past, of a multidisciplinary approach to the solution of developing problems. This implies the introduction of representatives of many disciplines including economists and political scientists, as well as applied mathematicians and physicists to this field and the creation of requisite institutes or centers for environmental health research at which needed personnel can be brought together.

29. The capability of graduate schools or university departments of engineering and public health to produce a sufficient number of engineers and scientists who are able to deal effectively with the mounting problems of water resource control must be enlarged by support of

staff, student body, and teaching and research facilities, as well as by grants-in-aid of research. Interdisciplinary research should be encouraged in particular. Because the use of personnel and the application of research lie in the public domain, the Federal Government must be expected to assume a substantial portion of the required financial burden.

30. The flow of treatment-plant operating personnel as well as engineers and scientists working in the wider field of water supply and water pollution control must be increased and their training broadened.

# APPENDICES

## APPENDIX I

Additions to the Record

## APPENDIX II

A. List of Exhibits

B. Films Shown

## APPENDIX III

Conference Participants

A. Members of Steering Committee

B. Members of Water Pollution Control Advisory Board

C. Conference Participants and Speakers

Preceding page blank

# APPENDIX I

## Additions to the Record

Participants at the National Conference on Water Pollution were invited to submit additional comments and points of view for the record, these comments to be received by the Executive Secretary on or before December 29, 1960. Following in alphabetical order are the communications which were received.

---

### STATEMENT SUBMITTED BY E. SCOTT PATTISON, DIVISIONAL MANAGER, IN BEHALF OF ASSOCIATION OF AMERICAN SOAP & GLYCERINE PRODUCERS, INC.

During the National Conference on Water Pollution, December 12–14, 1960, on several occasions questions were asked about the health aspects of the long-term ingestion of trace amounts of synthetic detergents in water. More specifically, the questions concerned ABS (alkyl benzene sulfonate), the surface active agent predominantly used in household detergents. In response to these questions, the Association of American Soap & Glycerine Producers, Inc., on behalf of the detergent industry, offers the following:

1. A review of the literature on acute and subacute toxicity studies entitled "ABS and the Safety of Water Supplies," *Journal American Water Works Association, 52*, 786–790 (June 1960), prepared by an AAS&GP committee, concludes that ". . . based on a conservative assessment, ABS can be consumed at concentrations at least several times those presently found in drinking waters without producing any long-term, physiological effects."

2. A chronic toxicity study entitled "The Chronic Toxicity of Sodium Alkylbenzenesulfonate by Food and Water Administration to Rats" by Tusing, Paynter and Opdyke, was published in *Toxicology and Applied Pharmacology, 2*, 464–473 (July 1960). This paper covers two separate 2-year rat feeding studies. In the first, levels of 0.5 and 0.1 percent (5,000 and 1,000 ppm) of alkyl benzene sulfonate derived from polypropylene, typical of that used in the manufacture of household detergents, were fed in the diets of the test animals.

Preceding page blank

In the second 2-year study, the ABS was supplied in the drinking water of the rats at a level of about 0.05 percent (equivalent to 0.1% in the diet). The levels in both studies were administered with no significant effects and afford a more than adequate factor of safety, even assuming that as much as one ppm of ABS might be present in the drinking water. The authors conclude: "To the extent that animal tests provide a basis for the assay of toxicity to humans, it would appear that these investigations assure that considerable amounts of ABS (much in excess of the amounts that might find their way into the drinking water) could be consumed over long periods without harm."

3. Another chronic toxicity study "Chronic Toxicity of Santomerse No. 3 From Olefin (Dodecyl Benzene Sodium Sulfonate)," by Paynter and Weir, was published in *Toxicology and Applied Pharmacology, 2,* 641–648 (November 1960). This paper reports the findings of 2-year feeding studies of ABS at levels of 0.2 percent, 0.1 percent and 0.02 percent (2,000, 1,000 and 200 ppm) in the diet. The results support those of the studies reported in 2 above, with the statement by the authors that: "No adverse effects were produced with respect to growth, food consumption, survival, hematological values, organ weights and organ-body weight ratios. Gross and microscopic examination of tissues revealed no pathological changes attributable to the ingestion of the test material."

4. Finally, it is our understanding that the U.S. Public Health Service Committee on Drinking Water Standards, which is proposing, for esthetic reasons, inclusion of a recommended limit of 0.5 ppm of ABS in the U.S. Drinking Water Standard when it is revised in the near future, has considered the toxicity aspects and has also concluded that there is more than an ample factor of safety in considering the trace levels of ABS which might occur in drinking water.

On the basis of the studies reported above, it appears that an ample factor of safety for the trace levels of ABS which might occur in water supplies has been demonstrated.

## STATEMENT SUBMITTED BY HENRY CONRAD BRAMER, UNIVERSITY OF PITTSBURGH

### THE ECONOMIC ASPECTS OF THE WATER POLLUTION ABATEMENT PROGRAM IN THE OHIO RIVER VALLEY

### *Abstract*

Stream pollution does not, in general, result from the willful destruction of a natural resource by persons of no social responsibility. It is caused by the excessive extent to which a surface stream is subjected to a normally legitimate water use, i.e., for waste disposal.

When this use of the surface waters results in social costs in excess of the aggregate benefits realized, it is controlled and regulated in the public interest. In the general case, these costs are reflected in many sectors of the socioeconomic structure. Whether or not a proposed program of pollution abatement is economically in the over-all public interest can be determined by a general analysis of the costs and benefits involved.

The objectives of this study have been to determine to what extent water-pollution abatement can be justified on an economic basis, and to develop and demonstrate the methods by which the economics of pollution abatement can be quantitatively studied on a river-basin basis. The Ohio River Valley was chosen as the area of study here. The use of the present work as a model for similar studies would require modification of the water-use categories and sources of pollution to be considered in the light of a comprehensive study of the region of interest.

The economic aspects of water-pollution abatement in the Ohio River Valley have been considered on the basis of quantitative data developed for the reference year 1958. The absolute and relative significances of the various uses of the surface waters in the region have been demonstrated through estimations of their annual values. The costs of pollution as reflected in the various water uses have been estimated with the reductions in such costs to be expected as the result of pollution-abatement measures. The costs of abatement in the various public and private sectors have been estimated. Net costs of pollution abatement have been shown as functions of the degree of abatement accomplished, and the nature of the economic optimum has been shown. The methodology of a study of the economics of water-pollution abatement in a river basin has been given, and attention has been directed to the need for additional data in certain specific areas.

The total net cost of pollution abatement has been shown to be critically dependent upon the effects upon water uses for recreation. An economic optium has been shown to exist in the range of pollution abatement corresponding to that between primary and secondary treatment; this optimum has been defined in terms of minimum net costs. A benefit/cost ratio exceeding unity has not been demonstrated and it is concluded that pollution abatement cannot be justified on an economic basis if it is assumed that such a ratio is a necessary condition.

The total value of the various water uses in the region is estimated to be about two percent of the area's contribution to the Gross National Product. The annual cost of pollution from all sources, including nature, is estimated to be equal to one-third of the total 1958 value of the water uses and to be reducible by about 60 percent with the adoption of feasible pollution abatement measures.

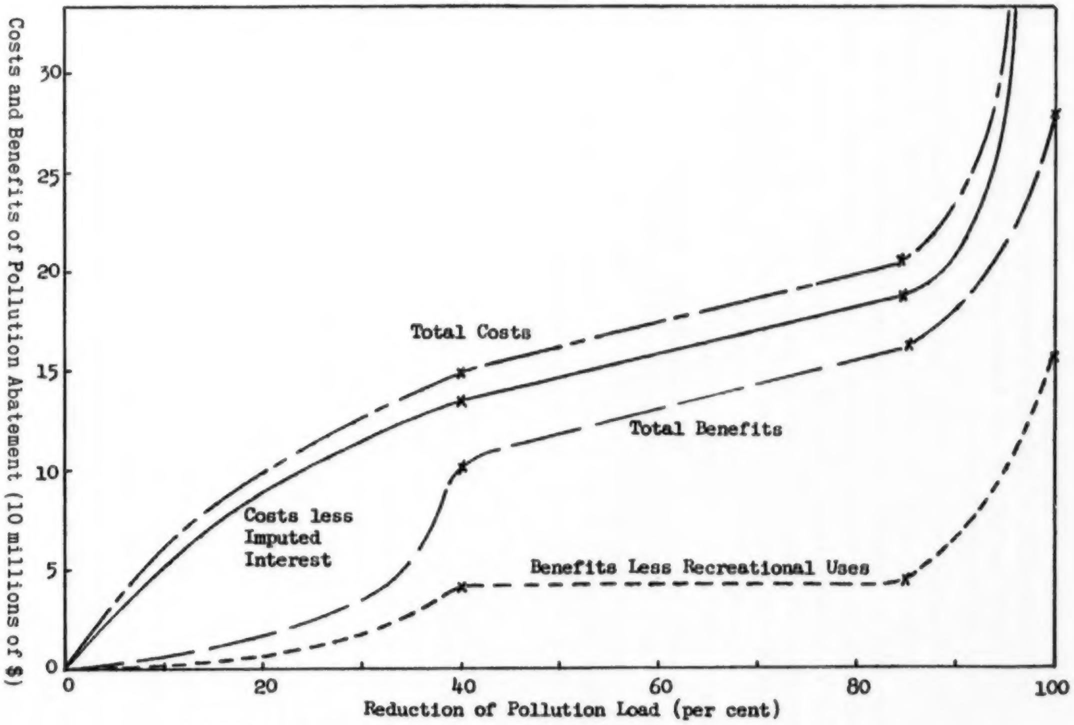


FIGURE 4.—Annual costs and benefits of water pollution abatement measures.

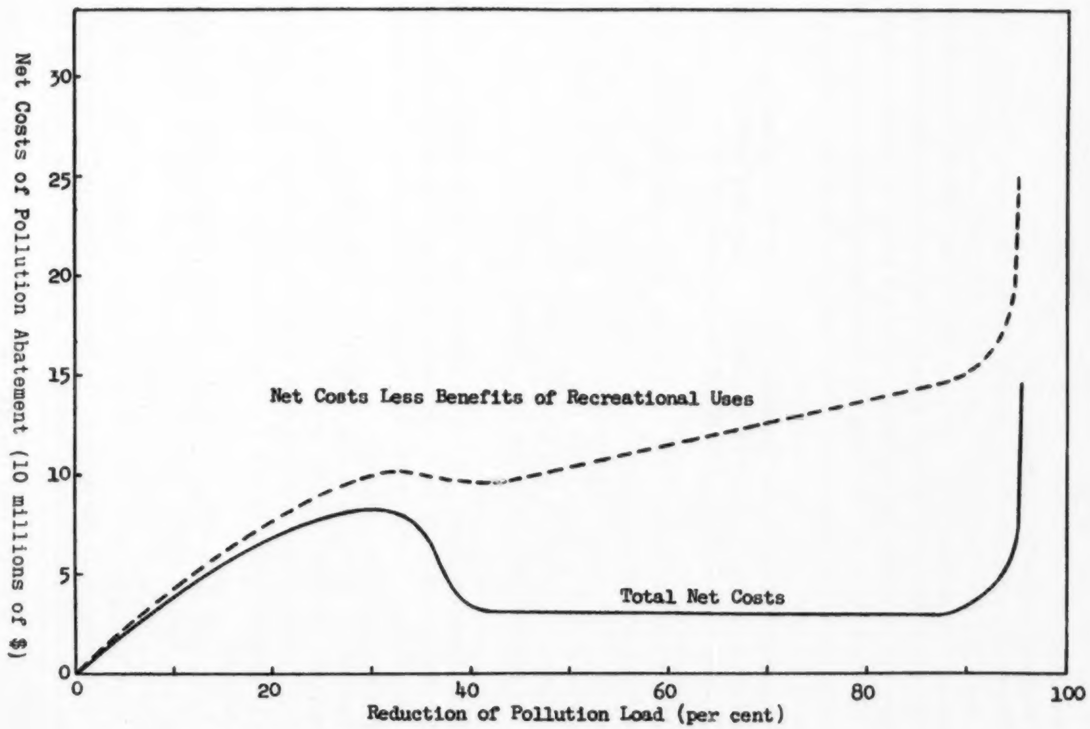


FIGURE 5.—Annual net costs of water pollution abatement measures

Economic justification is not a necessary prior condition to the implementation of a water-pollution abatement program. Political considerations are most often of primary importance. It is felt, however, that the best public interest would be served if those costs capable of measurement were known and used as guideposts in decision making by responsible public agencies.

The results of this study are largely summarized in graphical form by figures 4 and 5 of the manuscripts, which are reproduced here for convenience. The total costs and total benefits of pollution abatement in the Ohio River Valley are shown in figure 4 as functions of the degree of abatement accomplished; total net costs are shown in figure 5. The net costs are the total costs of noneconomic benefits and of economic benefits incapable of measurement. (See pages 576–577.)

---

## STATEMENT SUBMITTED BY RICHARD W. SMITH, MANAGER, NATURAL RESOURCES DEPARTMENT, CHAMBER OF COMMERCE OF THE UNITED STATES, 1615 H STREET N.W., WASHINGTON 6, D.C.

At the session of Panel III on Tuesday afternoon, December 13, I requested permission to make a short statement on the paper of Karl M. Mason on "The Needs and Obligations of State Agencies." Because of lack of time, I was not given an opportunity to make this statement. I therefore ask that the following statement be inserted in the proceedings—following Mr. Mason's paper:[1]

* * * * * * *

Mr. Mason's paper on "The Needs and Obligations of State Agencies" is shocking to me because of his willingness to abrogate to the Federal Government his responsibilities as a State stream pollution abatement official.

Instead of saying it is the obligation of the State to set proper standards of water quality and doing its best to enforce them, he says, "It becomes an obligation on their (State officials) part to support vigorous action by the Federal Government in developing such standards."

Again he states: "Water pollution control programs are so complex that the States cannot cope with these problems without the active assistance of the Federal Government."

Next he chides the Public Health Service because it "has been extremely sensitive to the rights of the States in water pollution control." The Public Health Service should be sensitive to the rights of the States.

He ends by saying that the State officers should "support a stronger role on the part of the Public Health Service in water pollution control activities."

---

[1] All statements received after the close of the Conference have been included in this Appendix rather than elsewhere in the text.

If this is the attitude of State officials, sworn to do their best to reduce stream pollution, we are indeed in a bad way. I believe, however, that Mr. Mason does not represent the views of many of the State stream pollution abatement officials.

The States, individually or through interstate compacts, are capable of handling the problem of enforcement, if they want to, and many of them are doing it. The proper role of the Federal Government is to furnish basic research and technical assistance, and with enforcement authority in the background to be invoked only if and when the State demonstrates either inability or unwillingness to do its own job. This authority is in the present Federal Water Pollution Control Act, and the act does not need to be amended.

***Editor's Note:*** Since this statement referred to a specific paper presented at the Conference, the author was given an opportunity to reply. The following is Mr. Mason's statement:

The Public Health Service has generously permitted me to comment on Mr. Smith's remarks concerning certain statements contained in my Panel III presentation.

First of all, I would like to express my pleasure in having an official of the U.S. Chamber of Commerce come to the defense and support of State water-pollution control agencies. Secondly, I would like to emphasize the fact that I am 1 of the 50 State program administrators referred to so often in my paper, and I believe that few persons familiar with Pennsylvania's water pollution control program during the past 10 years would ever accuse us of abrogating our responsibilities to the Federal Government. What, then, did I mean by the statements quoted by Mr. Smith?

The reader must keep in mind that a 15-minute paper is necessarily very concise and most sentences cannot be interpreted accurately if out of context. The two short paragraphs devoted to standards point out the danger of the States having different stream classifications or minimum waste treatment requirements for the same water uses. During the past decades the States haven't been able to reach an agreement, so why not let the Public Health Service try it with our, and others', help? They have done very well on the Standard Milk Ordinance and Code; the National Committee on Radiation Protection has a fine set of standards in that field, and even the Atomic Energy Commission is developing recommended regulations for State agencies to adopt for radiological health programs. None of these standards are Federal regulations and neither would the water quality standards be mandatory.

I do not know where to begin on the next statement that Mr. Smith questions; for to deny that we need the active participation of the Federal Government in our water-pollution control programs is to discount the invaluable services we all receive in technical assistance, research, and training which otherwise would not be available to State agencies.

It is true that I chide the Public Health Service for being too sensitive to the rights of States—within the context of the preceding paragraph to which that statement refers. When it is known that program grants distributed to the State agencies by the Service are not used to extend water-pollution control activities and, in at least one State, are not even credited as additional funds to the unit administering that program, then I say that's being too cooperative. My main plea there was that unless we, the States, relinquish some of our prerogatives of deciding just what we're going to do with Federal funds when they reach our offices, we might find another agency much less to our liking administering water pollution-control activities at the Federal level.

Mr. Smith then quotes the last phrase in my summary which supports a stronger role on the part of the Public Health Service. Since a summary must reflect the text, this statement must refer to the only two recommendations for Service activities—developing acceptable standards and coordinating water pollution control activities by reviewing the use of program grants—and it does.

Now, after these few quotes, Mr. Smith deplores the extension of Federal enforcement powers for pollution abatement—and coincidentally, so do I. In fact, I couldn't express most of my views better if I'd written his concluding paragraph myself. How can I disagree when I gave an entire page, among only four, to the importance of enforcement by State agencies? I can only wonder, therefore, where Mr. Smith received the impression that I was for the extension of Federal enforcement powers—I certainly didn't say or write it.

---

## STATEMENT SUBMITTED BY SAMUEL A. GREELEY, PARTNER, GREELEY & HANSEN, 14 EAST JACKSON BLVD., CHICAGO, ILL.

### 1. *Foreword*

This is a conference of great importance. Dr. Burney, after reference to President Eisenhower's veto message of February 23, 1960, in which the President requested the Secretary of Health, Education, and Welfare to arrange for a National Conference on Water Pollution, supplemented the President's message by stating, "Such a conference * * * will do much to build a national program against water pollution and to mobilize public opinion behind such a program."

This statement prompts two questions:

(*a*) What is to be the scope and nature of a national program?

(*b*) How is public opinion to be mobilized in support thereof?

Answering these questions will require a great knowledge and study of water pollution and its present status, and of its fundamental and realistic aspects. The Public Health Service has a fine record of achievement in advancing knowledge regarding water pollution and its abatement.

2. *What is water pollution?*

Under the old common law, no one had the right to change the quantity and character of water from its natural condition to the detriment of others without acceptable compensation. Pollution (and contamination) may be thought of as the causing of such changes in the character of water. However, this law or doctrine has been tempered by the needs of water for survival and by the relative needs of contending parties. The relation of costs to needs and to benefits is also a tempering factor.

3. *What is the present status of water pollution?*

A useful appraisal of the present status of water pollution and of pollution abatement seems to be a necessary start to the formulation of a national program and to the mobilizing of public opinion. Many competent sewage works have been built to abate pollution and a great number of research projects have been made and are underway. To illustrate, a few items pertinent to a description and appraisal of the present status are noted as follows:

(*a*) The largest cities in the nation have designed and built tremendous works for pollution abatement. These are New York, Chicago, Los Angeles, Philadelphia, and Detroit.

(*b*) A great many sanitary districts and sewer authorities have installed presently adequate sewage works to abate local pollution.

(*c*) Undoubtedly State sanitary engineers are aware of many smaller municipalities who have built and operate adequate sewage works.

(*d*) Compacts, such as the Ohio River, the Tri-State and the New England Commission have made great forward strides in pollution control and have a great volume of experience.

Experiences such as these give much realism to the present status of water-pollution control.

4. *What are the foundamental aspects?*

What fundamental aspects or considerations should guide the formulation of a national program and the mobilization of public opinion. In my view, based on responsible work on many pollution problems, neither the building of a national program nor the support of the public thereto will prevail unless the following fundamental considerations are firmly and acceptably established:

I. Real need.
II. Fair financing

### 5. *Local versus national objectives and interests*

There is no real difference between local and national objectives and interests if local need and knowledge on the one hand and national ability on the other are respected.

It seems clear to me that, locally, the need of water-pollution abatement as related realistically to costs and benefits can best be appraised and developed by those who are directly responsible to taxpayers and users.

### 6. *Is water pollution uniform throughout the Nation?*

The answer to this question is, of course, "No." Almost the first thing to be established in a program against water pollution is the standard of cleanness to be maintained in each important waterway. No single or uniform standard of cleanness is supportable. In print No. 29 of the Kerr committee, Professor Reid, of the University of Oklahoma, states: "In some instances, it may be found that the river cannot economically provide for all the uses desired, and a choice will be required as to the best possible future use of the river."

There is a growing number of adopted standards and of knowledge relative to their sufficiency. A very complete compilation of such standards is in "Water Quality Criteria" and "Water Quality Criteria—Addendum No. 1," by the State Water Pollution Control Board, Sacramento, Calif., 1952 and 1954.

Standards of cleanness should be established with due regard to—

(*a*) Assimilation capacities of waters receiving pollution.

(*b*) Realistic appraisals of waterway uses and applicable standards of cleanness.

(*c*) Realization that dollars are important and that expenditures must be warranted by needs and benefits.

### 7. *Informing the public*

It seems clear that the public should be made aware of the "hazards of pollution and of workable means for control"; but, to obtain public approval and support of pollution abatement projects, their need must be realistically established and the expenditures therefor must be fairly allocated. These two criteria are important considerations with respect to progress in pollution abatement. Realistic need and fair financing are important matters about which the public should be informed.

### 8. *Fair financing—Two-part rates*

In my opinion, it is essential that the financing of pollution abatement projects and procedures be altogether fair. Reference should be made to the so-called Joint Report of the American Bar Association, the American Society of Civil Engineers, and six other national groups, published in 1951. This report presents the fundamental consideration that users or persons directly benefited on the one hand

and property on the other should each contribute to the total annual revenue needed for operation, maintenance, and debt service in proportion to the amount which each causes to be spent. In my opinion the resulting two-part rates are the fairest method of financing pollution abatement projects.

In a paper before the Philadelphia Congress in October 1960, Curtiss M. Everts, of the Oregon State Board of Health, states that, among other things, State agencies are hampered in accomplishing pollution abatement by "antiquated financing methods."

The subject of fair and unfair financing was discussed by the writer in a paper before the bar association at their Cleveland meeting in 1947 and was reprinted and distributed by the U.S. Public Health Service shortly thereafter as "Some Fundamental Considerations in Revenue Financing of Water Supply and Sewage Disposal Projects with Special Reference to Rate Structures."

### 9. *British attitude*

No brief description of the British attitude toward the water pollution problem on my part is practicable or proper. However, the problem has been active and pressing in Great Britain for over 85 years. Their experience should be helpful in arriving at statements and recommendations in reply to the President's message.

There is a very competent book published in Great Britain and written by Louis Klein, chief chemist of the Mersey River Board, entitled "Aspects of River Pollution." A quotation from chapter 14, Standards for Rivers, Sewage Effluents and Trade Effluents, is pertinent to this Conference, as follows:

> Before making bylaws, a river board must carry out a thorough survey of the river or rivers for which standards are required. Data needed for this purpose would have to include flow measurements and analyses of the stream at a number of points and information on the volumes and character of all sewage effluents and trade effluents discharging to the stream. A decision would have to be made on the quality of water needed in the river, or in different parts of the same river and, in this connection much would depend, to use the words in section 5 of the act, on "the extent to which the stream is or may in the future be used for industrial purposes, fisheries, water supply, agriculture, transport, or navigation.

### 10. *Statements by Secretary Flemming*

The Secretary gave a preview of this Conference in his remarks to the Water Pollution Control Federation in Philadelphia on October 4, 1960. He suggested an opinion that this Conference would—

(*a*) Specifically identify the controversial issues.
(*b*) Hear opposing views.
(*c*) Make specific recommendations.

He then suggested that action is required to—

(*d*) Establish national goals in research.
(*e*) Apply the results of research.
(*f*) Get industry and government to act.

He expressed a conviction that action by the Federal Government is required and recited seven important areas of Federal action. He suggested four recommendations for legislation as follows:

I. Make enforcement procedures available to the Federal Government but only upon request by a State;

II. Improve enforcement procedures by providing for their initiation by a municipality adversely affected by pollution;

III. Clarify and strengthen the Secretary's role in the enforcement process;

IV. A "draft bill" which would amend the definition of "interstate waters" to include waters which flow across or form a part of a State boundary.

The foregoing, I think, should be carefully adjusted to the fundamental aspects stated above.

### 11. *Statement by Water Pollution Control Federation*

The Board of Control of the W.P.C.F. in session in Philadelphia, Pa., on October 6, 1960, adopted a policy statement in 13 sections. This is an important contribution meriting full consideration in the deliberations of this Conference. Some of the sections of this statement appear to conform to the fundamental aspects, such as the following:

> 2. That the type and extent of treatment and control for any specific situation must be determined after consideration of the technical factors involved.
>
> 3. That the responsibilities for the adequate treatment and control of wastes to overcome pollution must be shared individually and jointly by industry and local, State, and Federal Governments.
>
> * * * * * * * *
>
> 6. That the administration of State and interstate pollution control programs should remain in the hands of State and interstate water pollution control agencies which must be supported by increased budgets and adequately staffed by well-trained and compensated engineers, scientists, and other personnel.

### 12. *Statement of water pollution control administrators*

These administrators at their meeting in Chicago on January 26 and 27, 1960, arrived at a considerable number of comprehensive "Conclusions and Recommendations" in the field of water pollution control. Several statements in this document seem to conform to and support the fundamental aspects of the problem such as the following:

(*a*) With reference to this Conference, two things were said to be of paramount importance:

1. Adequate financing.
2. Meticulous planning.

(*b*) That the States have primary responsibility in pollution control,

(*c*) That Federal Government authority * * * be exercised only after other enforcement agencies have failed * * *

Many other of the conclusions and recommendations of the State and interstate water pollution control administrators deserve study in the preparation of statements to satisfy the request in the President's message.

13. *Summary statement*

Answering the request of President Eisenhower for advice relative to Public Law 660 and his veto of an amendment thereto calls for thoughtful, competent, and responsible effort. Inherent in the problem is the relation between the roles of Federal, State, and local agencies. This is a matter of profound concern about which there are differing opinions in other areas of national practice. On this account, the conclusions of this Conference will be important. But within the specific field of water pollution to which this Conference is directed, some fundamental aspects are recommended for consideration as described in the foregoing and summarized as follows:

> (*a*) No solution of the water pollution problem will receive or merit adequate public support unless a realistic need is established and unless the method of financing is fair.
>
> (*b*) Locally acceptable standards of cleanness for each waterway should be prepared and used as guides for needed abatement projects.
>
> (*c*) In adopting standards of cleanness and abatement projects, due regard should be given to assimilation capacities, realistic appraisals of waterway uses and needs, and to a reasonable regard to overall economy and dollar conservation.

In closing, I congratulate and compliment the U.S. Public Health Service for its able promotion of a great National Conference on Water Pollution and for its many contributions to the advancement of good sanitation.

---

## STATEMENT SUBMITTED BY JOHN E. HULL, GENERAL, U.S. ARMY (RETIRED), PRESIDENT, MANUFACTURING CHEMISTS' ASSOCIATION, INC., WASHINGTON, D.C.

As president of the Manufacturing Chemists' Association, speaking to the American Institute of Chemical Engineers on December 7, 1960, I stated that the MCA Water Pollution Abatement Committee is now formulating a set of principles as follows:

> The surface waters are one of the Nation's most valuable, renewable natural resources. This vital resource must not be destroyed by uncontrolled stream pollution. The chemical industry, as well as all other industry, has a great stake in this water resource. Growth and development depend upon it.
>
> Proper control of stream pollution is one of the obligations of responsible corporate citizenship.

Avoiding harmful pollution is a necessary business cost. As with other aspects of business, qualified people with clearly defined responsibilities must be assigned to bring and keep pollution under control.

Adequate waste control facilities must be included in the design and construction of new plants and major additions to existing plants.

Adequate research in waste control is essential.

The chemical industry recognizes the community nature of water pollution control and desires to cooperate fully with the control agencies that are responsible for safeguarding the health and welfare of the people.

When new laws and ordinances are being considered, the chemical industry pledges itself to be a constructive contributor in promoting measures which will be sound, effective, and equitable.

The employees and the general public should be kept informed on the waste treatment and stream pollution control program underway at each plant. Knowledge of and acceptance by the public is the measure of success of a control program.

Information on waste treatment should be exchanged with other industries working in the field. Waste control personnel should be encouraged to prepare and present appropriate waste treatment papers. Those people with experience with the many complex problems should be encouraged to support and participate in the activities of the waste-control organizations serving in the field.

The solution of stream pollution problems of the individual companies is not a determining factor in competitive production and, therefore, the knowledge pertaining to solution of these problems should be freely shared.

I believe it is clear from the foregoing that we fully appreciate the importance of an adequate supply of water of quality appropriate for its intended use; as one segment of industry, we will continue to exert our best efforts toward this goal. While we recognize the problems incident thereto are substantial, and somewhat pressing in terms of careful and thorough planning, we reject the idea that these problems are already of crisis proportions.

We know that informing the public is necessary and desirable. Since each one of us as a member of the public body in the end must be convinced to bear the required cost, we pledge to aid in disseminating accurate well-founded information but we decry overemphasis or the sounding of unwarranted alarms.

Needs for the future to insure continuing progress are primarily in the technical area, for the most part demanding research. Most pressing of all is the answer to the question: "How clean does water need to be?" This has yet to be established. Quality criteria should be developed in relation to water use. It is economically wasteful—and wasteful of time and talent—to meet arbitrary requirements more stringent than necessary. Following close upon the definition of water quality is the problem of identification and quantitative analysis of critical substances. Such activities perforce call for greater numbers of trained personnel. It is logical to look to the Federal Government for leadership and coordination of these technical advances, in view of their broad utility and applicability.

Just as we visualize gain from centralization of research effort on problems which are technically similar, we are firm in the conviction that decentralization of enforcement authority should be preserved, to reside insofar as possible in the States or local communities. The problems of administration and control differ from one watershed or river basin area to another. The best assurance that they will receive appropriately singular judgment, taking due account of the impact on the area in question, will come from responsibility resting within the hands of those directly representing the population of this same area. We believe the fine record of State regulation, together with interstate compact authority on problems affecting more than a single State, warrants continuance of this design.

Echoing the theme of Mr. A. E. Forster's address to the Conference, the chemical industry will continue to need water for its very survival. Also, we are conscious that industry's employees, just as much as other segments of society, are vitally interested in recreational and agricultural uses, and in plentiful supplies of healthful potable water. We shall work unremittingly to accord proper balance to all needs of water as responsible corporate members of the communities in which we operate.

---

## STATEMENT SUBMITTED ON BEHALF OF THE CONSERVATION AND MANAGEMENT OF NATURAL RESOURCES COMMITTEE OF THE NATIONAL ASSOCIATION OF MANUFACTURERS OF THE UNITED STATES BY DONALD J. HARDENBROOK, CHAIRMAN, CONSERVATION COMMITTEE

### I

### WATERSHED IMPROVEMENT THROUGH COMMUNITY WATERSHED ASSOCIATIONS

Our general viewpoint on matters involving water and soil conservation is that natural watersheds are, in most cases, the most feasible units for conservation, development, and wise utilization of these renewable natural resources. It is also our belief that the watershed development concept should embrace the whole complex of renewable natural resource problems, including abatement of pollution, erosion prevention, protection of municipal and industrial water supplies, upstream water flow retardation, flood control, drainage and irrigation where necessary, recreation, and forest and range management.

In watershed development, we believe that local responsibility for action should be assumed by community watershed associations, soil conservation districts, or other voluntary local and State groups. Such watershed associations are ideal vehicles for permitting industrialists, bankers, businessmen, sportsmen, farmers, clubwomen, members of youth groups, and other individuals to cooperate together in solving problems related to adequate water supplies and flood control.

Where a unified approach on a large stream basin is most feasible, we advocate that a federation of community watershed associations on a State or interstate compact basis be encouraged to develop and carry out necessary plans. Wherever necessary to permit the effectuation of these principles, the various States should consider the adoption of suitable legislation recognizing watershed development as a State or interstate compact responsibility.

Therefore, we wish to express support for the viewpoint expressed by Mr. Edward R. Thornton, President, New England Interstate Water Pollution Control Commission, opposing expansion of Federal regulatory authority.

## II

### WATER-QUALITY MANAGEMENT IN INDUSTRY

In the field of water-quality management, industry is spending millions of dollars for research and for the application of existing knowledge in the form of control devices. One very large modern industrial plant, constructed in recent years, was engineered so that it returns water of better quality to the adjacent river than the water it withdraws from the river. In-plant control is recognized as the first line of defense against water pollution, and great progress has been made in many individual plants in rearranging manufacturing processes so as to minimize waterborne industrial wastes. Other preventive work has included a search for materials that do not contain substances deleterious to water quality. For example, one automobile manufacturing company reports that, by cooperative efforts with its supplier-vendors, phenols have been removed from such purchased materials as coolants, drawing compounds, preservatives, and paint strippers. This has resulted in an elimination of phenols from plant waste effluents. Industrial water-cooling towers have been adapted to serve a dual purpose as bio-oxidation towers to purify plant effluent and reduce pollution. Another promising new development involves recent experiences with oxidation ponds as an economic alternative to more elaborate treatment plants. These oxidation ponds, also known as aeration lagoons or stabilization basins, have great possibilities for small industrial plants and small communities. Solar radiation and algae team up to neutralize the wastes.

Industry supports the National Technical Task Committee on Industrial Wastes, comprised of representatives of 36 major using industries. The Task Committee exchanges information on industrial wastes problems and formulates a priority list of research projects in the water quality control field for the consideration of the Surgeon General of the U.S. Public Health Service. At its meetings, the various industries report the progress each is making. Some excerpts from these reports are suggestive of developments in this field:

### *Beet Sugar Industry*

"The industry continues to add facilities which will improve the quality or reduce the quantity of waste water discharged from the sugar and byproduct processing plants. The reduction in the pollutional characteristics of the waste waters is accomplished in various ways.

"During the past year, three new byproduct plants have been built to produce dried molasses beet pulp. New screening facilities have been provided at six plants to remove additional organic solids from waste waters for process use and other purposes. More interest is being shown in the use of algae in treatment ponds."

### *Canning Industry*

Trickling filter experiments: "An investigation has been made of the use of shredded tree bark as a filter medium in trickling filter treatment of liquid canning wastes * * *"

Spray irrigation disposal of cannery wastes: "Spray irrigation is increasing in use as a method of disposing of liquid cannery waste. Under suitable conditions this method prevents stream pollution and odor problems * * *"

### *Meat Industry*

"The meat industry is progressing on a broad front in the fields of waste prevention, waste utilization, and treatment. The use of recirculated settled effluents as flushing and spray water in inedible operations has markedly improved effluent characteristics at many plants * * *"

### *Poultry and Egg Processing Industries*

"The past year has seen continued advances in waste prevention, utilization, and treatment in the poultry industry. Construction of new, larger plants to replace small, inefficient processing plants has brought waste treatment into the realm of economic feasibility in many instances * * *"

### *Dairy Industry*

"During 1959 the big emphasis on waste treatment in the dairy industry was in the field of disposal by land irrigation. In the State of Wisconsin, definite figures are available on dairy plants using irrigation disposal methods. Prior to 1957, there were 16 ridge and furrow irrigation installations in Wisconsin. During 1958 and 1959, to date, an additional 18 spray irrigation systems have been installed, along with 8 ridge and furrow installations. It is also known that there has been a large increase in the number of these irrigation projects in the State of Minnesota, although exact figures are not available * * *"

### *Steel Industry*

"The following report deals primarily with research supported by the American Iron & Steel Institute at Mellon Institute.

"An investigation of the behavior of suspended solids is one of the principal projects of the fellowship * * *"

"The actual effects of suspended solids on stream water has been the subject of considerable speculation. A long-term study is planned to evaluate the effects of suspended material in terms of particle size, turbulence, photosynthesis, and the like in natural streams. Quantitative data in this field is essential to rational regulation of the discharge of suspended solids * * *"

### *Bituminous Coal Industry*

"Progress has continued in the bituminous coal industry's fight to reduce or ameliorate its waste discharges. There are two general areas in which these activities have been conducted.

"Considerable and continued progress has been made in the abatement of the flow of black water (suspended solids) from coal preparation plants. This is particularly true in West Virginia and in Virginia, where a great amount of effort and money has been expended to redesign and rebuild waste disposal systems so that the effluent will comply with State requirements.

"Research work has been continued on the acid mine drainage problem. Of greatest importance is a continuing project to operate a (deep) coal mine in such manner that a minimum of acid will be carried out in the mine drainage. This experiment, undertaken about 3 years ago with the guidance of the coal industry's research group at Mellon Institute, has continued to look encouraging. We can, however, draw only some encouragement, rather than conclusions, from the results, as this program must be continued for a period of 5 to 10 years before data of an indicative nature can be expected."

### *Coke Industry*

"Considerable progress was made by the coking industry during 1958–59 in the reduction of water pollution and air pollution arising from effluents from the byproduct coking works. In regard to the liquid effluents, several of the byproduct coking plants installed recirculating quenching stations or improved the existing ones so as to reduce the volumes of waste water from the quenching of the hot coke. In some of the plants the still wastes which contain some phenol were used as quenching water, and this reduced the quantity of phenols going to the public waterway. Another important improvement was the installation at several byproduct coking plants of improved types of dephenolizers or the reconditioning of old dephenolizers so as to remove more of the phenols from the feed liquors.

"* * * When it is realized that the construction and installation of a modern dephenolizer with the necessary instruments which are required for its operation may cost over $1 million, it is apparent that the companies which have constructed new dephenolizers are not hesitating to expend considerable sums of money to reduce stream pollution.

"The high cost of waste treatment for an integrated steel plant having an annual production of 1,800,000 tons may be broken down as (1) sanitary sewage, $1,700,000; and (2) industrial waste disposal, $1,800,000. Fifty percent or more of the industrial waste costs are chargeable to the coke plant and related operations."

### *Petroleum Industry*

"The petroleum industry has continued to expand its broad activity in water and air pollution abatement in the past year. Much of this work was reported during meetings of the American Petroleum Institute Committee on Disposal of Refinery Wastes which met in New York in May and again in Denver in October 1959, with approximately 60 oil industry representatives in attendance at each meeting.

"During the year the committee (CDRW) issued a revised new edition of volume 1 of the API Manual, 'Waste Water Containing Oil.' This edition contains new information on industry practice in vapor recovery in oil—water separators, air flotation techniques, and flow measurement procedures * * *

"A technical symposium held during the May 1959 meeting developed that approximately 12 full-scale biological oxidation treatment plants have been installed in refineries in the United States and Canada since the first such commercial installation in 1954."

### *Gas Industry*

"During the past 15 to 20 years, and especially during the last 5 to 10 years, the commercial gas industry has changed very largely from the use of gas manufactured from coal and oil to natural gas. With the completion of the 'Big Inch,' the 'Little Inch,' and other transcontinental pipelines, natural gas is now available in nearly all the large cities of the United States. This has eliminated most of the waste treatment problems. Those which remain fall almost entirely into two categories.

"One of these is the disposal of the waste products resulting from the manufacture of peakload and standby gas. The principal waste product resulting from these operations is tar, a product with which our industry has had long experience. For many years these tars have been treated with various products to break the tar water emulsions, and the tar has either been sold for further processing by chemical companies or for use as a roadmaking material, while the remaining water has been treated to eliminate traces of tar before discharge. Since the total volume of gas manufacture is only a small fraction of what it used to be, and since this manufacture is normally carried on for only a few days each year, the waste disposal problem is only a fraction of what it used to be.

"The other basic type of problem has to do with disposal of muds and brines used in the drilling for gas wells, or produced by the wells. The muds are not usually discharged to streams, but are retained for use in the drilling work. Considerable progress was made during 1958–59 by the commercial gas industry in the development of methods for ponding and underground disposal of the salt brines * * *"

*Chemical Manufacturing*

"The chemical industry has been implementing its program of inplant waste reduction, which has materially assisted in the overall pollution reduction program. In this work many new phases of control are being utilized which, with new approaches to treatment of certain discharges, have entirely removed them as a pollutant. As an example of the latter, the incineration of phenolic wastes in the furnace of a waste heat boiler completely solved the problem.

"New waste treatment plant construction has been accelerated which has had its effect on reduction of pollution. These have been mainly biological oxidation systems.

"More and more consideration is being given to joint facilities with municipalities for combined treatment of both municipal and industrial waste. In some the industrial waste is treated in the municipal plant. In others, notably the American Cyanamid plant at Bound Brook, N.J., now in operation, and that of Union Carbide Chemicals Co. at West Charleston, W. Va., now under design, are systems where the municipal wastes are treated in the industrial plants. Along with these, investigations have shown that certain toxic wastes previously thought untreatable biologically are now being destroyed where mixed with sanitary sewage in the regular biological treatment facilities.

"Close cooperation between the chemical industry and regulatory agencies has been shown to work out to the benefit of both, as has been developed in the Kanawha River valley. Here the industries have worked with the Commission in the development and carry-through of a program of river study and control * * *

"For the chemical industry, the Manufacturing Chemists' Association has set up a program with the Franklin Institute of Philadelphia for research on taste and odor in water."

### *Pulp, Paper, and Paperboard*

"There have been a number of significant research and applied developments in the field of pollution abatement in the pulp and paper industry during 1959. These have come in such areas as sludge dewatering, color removal, secondary treatment and in the field of chemical recovery of pulpmill effluents. The progress made in these fields is described below.

Sludge dewatering: "The problem of disposing of the hydrous sludges resulting from the clarification of pulp and papermaking effluents is perhaps the most troublesome one still confronting the industry. The difficulty in dewatering these sludges may be attributed to the high quantity of colloidal sols present.

"During the past several years, the National Council for Stream Improvement (NCSI) has been studying the applicability of centrifuge methods for the efficient dewatering of these materials. Both laboratory tests and plant-scale work at various types of pulp and paper mills has been conducted with encouraging results * * *

Color removal: "The national council has been working on the problem of removing color from kraft mill bleaching effluents for some years. During the past several months a new process has been developed which removes 75–95 percent of the color in the caustic extract effluent and can be integrated with the mill recovery process * * *"

Secondary treatment: "The pulp and paper industry as a whole is doing an excellent job with respect to the removal of settleable solids. In certain areas, however, dissolved oxygen problems exist in the stream which necessitate further treatment of these effluents. A number of biological treatment approaches are being tried to reduce the biochemical oxygen demand of these effluents."

General research developments: "Aquatic biology problems are being studied for the industry at the University of Georgia, Oregon State College, North Carolina State College, and the Institute of Paper Chemistry."

### *Textile Industry*

"The interest reported in 1958 in research in textile waste treatment has been accelerated by findings in more practical and economical approaches to the solution of abatement problems.

"Excellent research results in a contact aeration method at one textile plant show that biochemical oxygen demand removals up to

90 percent have been obtained in experimental plant runs of mixed mill waste sewage. Great savings and economy in plant construction are indicated in these processes, as well as in the biosorption method * * *."

"Many textile plants are placing more emphasis on in-plant reduction of waste as an approach to solving pollution problems. Plants located on large streams are giving critical consideration to the substitution of starch with synthetic sizing agents in slashing operations.

"At one textile plant the pollution load to stream has been reduced about 50 percent by spraying the mill waste on a large, isolated field, letting it trickle to the stream.

"An important note which may be considered an advance in waste treatment, particularly in the South, is a better understanding and awareness of the problems involved, and closer cooperation with regulatory agencies in seeking solutions to the mill waste treatment problems."

### *Automotive Industry*

"A survey of industrial waste activities during 1959, in the automotive industry has been made by the Advisory Group on Industrial Wastes and Water Resources of the Automobile Manufacturers Association. Results of the survey are furnished herewith for information of the Task Committee.

"Automotive companies have continued active progress in the control of wastes which are typical for the industry. Furnished below is an outline of facilities placed in operation during the past year, and some of these being planned."

Facilities installed: "Facilities to treat process wastes from painting and assembly operations have been installed at the assembly plant at St. Louis, Mo. The facilities are for batch treatment of wastes, and include two 80,000-gallon reaction tanks and two 500,000-gallon lagoons.

"Five assembly plants have installed air flotation units for treatment of water-dispersible paints. Four of these plants are in the Detroit area: Plymouth, Dodge, Chrysler, and Windsor. One is in Newark, Del.

"The Newcastle, Ind., plant has installed an air flotation system for treatment of soluble oil wastes.

"One additional treatment tank was installed at Mahwah, N.J., assembly plant for treatment of spray booth waste water.

"A new industrial waste treatment plant has been placed 'on stream' at the diesel equipment division, Grand Rapids, Mich., for the treatment of plating wastes and oily wastes.

"Chevrolet division has placed in operation facilities for oil separation and solids sedimentation at an aluminum foundry.

"A new industrial waste treatment plant is now in operation at Fisher body division, Willow Run, to handle general manufacturing wastes formed in the manufacture of 'Corvair' bodies.

"Chevrolet division has also provided waste treatment facilities for Corvair production at Willow Run * * *."

Development activities: "A significant development covering a new approach to the reduction of hexavalent chromium by exposure to power house flue gases containing $SO_2$ was reported at the 1959 Purdue conference by Mr. J. Canan, Brown-Lipe-Chapman Division, Elyria, Ohio. An installation utilizing this method has been in successful operation for a number of months.

"Several divisions are currently designing or constructing new treatment facilities."

Another important function of the National Technical Task Committee is the formulation of industrial waste guides for each industry. The most recent publications are industrial waste guides for the milk-processing industry, the cotton textile industry, and the cane sugar industry. This is part of a twofold publicity program on the part of NTTCIW to achieve the following purposes: (1) to bring about adequate awareness within industry, and (2) to effect an understanding outside of industry on problems, accomplishments, and all other aspects of industry's role in improving the quality of the Nation's water resources.

Other activities of this Task Committee include stimulation of interest in programs for training industry personnel to provide the competencies needed for carrying out industrial waste-control programs, and cooperation with the U.S. Public Health Service in basic data programs and studies at the Sanitary Engineering Center.

Industry is vitally interested in the wise use of our water resources and is actively cooperating with both voluntary and regulatory groups in the cause of pollution abatement. As the material set forth above demonstrates, there are many technical and economic problems involved. Any statement of objective that could mislead the public into believing that such technical and economic problems are not involved would be unfortunate for the goal of real progress. Therefore, we wish to express disagreement with some of those at the Conference who believed that reference to such problems should be omitted from a statement of objective.

## STATEMENT SUBMITTED BY THE NATIONAL TECHNICAL TASK COMMITTEE ON INDUSTRIAL WASTES CONCERNING RECOMMENDATION NO. 1 OF PANEL III

At the annual meeting of the National Technical Task Committee on Industrial Wastes on December 15, 1960, there was discussion of the problem which developed in the final plenary session of the National Conference on Water Pollution of combining the No. 1 recommendations of Panels I and III.

Time limitations and other factors at the plenary session were not conducive to the reaching of a properly considered decision.

As a result, dissatisfaction was expressed by many that recommendation I as drafted by Panel I was also adopted by Panel III in place of their original draft.

In the interest of reconciling the points of view expressed by Panels I and III and at the same time attempting to preserve the sense of the participants at the Conference, we would respectfully suggest acceptance of the following consolidated statement which preserves the meaning and intent of the original recommendation I of Panel I and recommendation I of Panel III:

"We recommend that the Conference express its conviction that the goal of pollution abatement is:

> "(*a*) To protect and enhance the capacity of the water resources to serve the widest possible range of human needs; and
>
> "(*b*) That this goal can be approached only by accepting the policy of keeping water clean, consistent with the variabilities within and among different river basins."

## STATEMENT SUBMITTED BY KENNETH H. SPIES, PORTLAND, OREG., ON BEHALF OF POLLUTION CONTROL COUNCIL, PACIFIC NORTHWEST BASINS

### PLANNING FOR MUNICIPAL AND INDUSTRIAL WATER SUPPLY REQUIREMENTS

The problem is essentially one of planning cooperatively to make the best use of our water resources to assure for the future, an adequate supply of water safe for human consumption and an adequate supply of clean water to support industrial development.

While the Water Supply Act of 1958 fulfilled a part of this need insofar as Federal water-development projects were concerned, a new and supplemental authorization is needed to enable the Public Health Service to cooperate with State and interstate agencies in planning for the development and use of water resources for domestic, municipal, and industrial purposes.

The objective of this proposed authorization would be to make the extensive facilities of the Public Health Service available to State and interstate agencies to enable them to develop new methods, and undertake the technological and economic studies and research required to solve the complex metropolitan, regional, and interstate water problems.

### *Water Pollution Control*

The Federal Water Pollution Control Act of 1956 established a good foundation to meet and solve the complex problem of pollution control in the Pacific Northwest as well as the Nation. It is desirable however to provide for increased financial assistance to municipalities and other political subdivisions for the construction of sewage-treatment work. It is also desirable to extend the financial support to State and interstate water-pollution control agencies to enable them to maintain effective pollution-control activities and to continue the cooperative State-Federal pollution-control activities programs.

### *Research*

There are increasing signs that unless major technological breakthroughs are achieved within a few years, an increased portion of our waters will become unfit for use even with the full application of present-day knowledge for treating sewage and industrial wastes.

Answers to these problems must be obtained in the immediate future. The speed and accuracy with which the problems are solved depends entirely on the accumulation of new knowledge obtained through research and investigations.

There is therefore an immediate need for the provision of funds to expand the research program. In addition, one of the proper places in which answers to problems of the Pacific Northwest may be sought would be through the establishment of a Pacific Northwest Regional Laboratory of the Public Health Service.

### *Low Flow Augmentation in Federal Construction Projects*

Water quality is usually adversely affected by extremely low waterflows particularly during periods of high-water temperatures.

Increasing the quantity of water in streams during periods of low flow will bring about a general improvement in the quality of these waters which is so important in maintaining them in a satisfactory condition for the propagation of fish and aquatic life, for recreational enjoyment, and for use as domestic and industrial water supplies.

Consideration should be given to the provision of general authority to the Federal construction agencies to include low-flow augmentation as an authorized function in planning water development projects. Because benefits from low-flow augmentation are general, widespread, and nonspecific, the provisions required to provide them should be considered as nonreimbursable in Federal projects.

There is one important policy point with respect to this matter. The provision of augmented flows is not to be used for the abatement of water pollution in lieu of full and complete sewage and waste-treatment facilities by cities, industries, or others concerned.

---

STATEMENT SUBMITTED BY R. HOBART SOUTHER, GREENSBORO, N.C.

Much has been said about the need for funds for more research by the Federal agencies. In my opinion the present funds would be more successful if greater emphasis was given to the research directly applicable to pollution abatement.

I would like to state that industry has contributed far more in research toward cleaning up the streams of the nation than the governmental agencies. Federal research funds now are largely spent on basic research rather than on the applied research which would give more direct benefits to both industry and municipalities. Lower cost methods of waste treatment are needed to obtain universal acceptance by industry and thus ensure a complete cleanup of the nation's streams. Industry is moving forward in both research and construction to solve its problems, particularly the textile industry which I represent.

An article, "Latest Word on Low-Cost Mill-Waste Disposal," in June 1960 *Textile World* states "Local and State laws are getting tough about mill-waste disposal. It's a hard problem. But today, with new methods and better equipment, waste disposal isn't the costly job it once was." The great progress being made in acceptance and application of the lower-cost waste-treatment processes, based on prolonged bio-aeration, may be found in more detail in *American Dyestuff Reporter*, October 3, 1960, and Proceedings NTTCIW, 1959, page 54.

These new waste-treatment processes developed by industry approach the lower cost oxidation pond treatments, and further additional applied research by Federal and State agencies in prolonged bio-aeration methods is suggested.

# APPENDIX II

## A. List of Exhibits Shown at the Conference

*Pennsylvania State Department of Health.* An exhibit showing the effects of a stream improvement program on a typical community.

*The Water Pollution Control Federation.* An exhibit showing the work of the Water Pollution Control Federation in promoting and advancing water pollution control activities.

*American Water Works Association, Inc.* A display of aids for the management and engineering of water supplies.

*Corps of Engineers—Department of the Army.* An exhibit portraying the importance of pollution abatement in comprehensive river-basin development, along with flood control, navigation, public recreation, hydroelectric power development, fish and wildlife, water supply, and other beneficial purposes.

*Department of the Interior—Geological Survey.* An exhibit portraying the activities of the Geological Survey in water resources investigations, with particular reference to chemical quality of water and sedimentation.

*Conference Book Service.* A comprehensive exhibit of professional books of special interest to technical and administrative personnel engaged in water pollution control activities.

*Department of Health, Education, and Welfare—Public Health Service—National Conference on Water Pollution.* An exhibit announcing the Surgeon General's call for a National Conference on Water Pollution and showing the major river basin areas in the United States.

*Department of Health, Education, and Welfare—Public Health Service—Sanitary Engineering Center.* An exhibit illustrating new techniques for the isolation, identification, evaluation, and treatment of new wastes entering our streams.

*Interstate Commission on the Potomac River Basin.* An exhibit depicting the commission's work in water pollution control in the upper basin and in the Washington metropolitan area.

*Potomac River Development Association.* An exhibit portraying the development of the Potomac River basin and the benefits to be derived therefrom.

*Department of Interior—Bureau of Reclamation.* An exhibit portraying the multiple-purpose benefits of water development, with emphasis on water pollution control.

*Department of Health, Education, and Welfare—Public Health Service—National Water Quality Network—Sanitary Engineering Center.* An exhibit demonstrating the coverage of the Public Health Service National Water Quality Network, and levels of radioactivity, coliforms, organic chemicals, and other materials discharged into our watercourses.

*Department of Health, Education, and Welfare—Public Health Service—Sanitary Engineering Center—Mobile Water Laboratory.* The Public Health Service mobile trailer laboratory used throughout the United States for short-term stream survey.

## B. Films Shown at the Conference

A selection of motion picture films, describing various aspects of water pollution control, were shown each day of the Conference:

*Clean Waters.*—16-mm., color, sound, 25 minutes. Produced by General Electric Co. Presents facts on America's waters, water pollution and sewage treatment. Film was a prize winner in competition with other documentary films produced by industry.

*George Washington's River.*—16-mm., color, sound, 28 minutes. Produced for the Public Health Service as a general-purpose feature to generate public awareness of the menace of water pollution. Uses Potomac River and the Nation's Capital as examples. Available on loan from State game and fish, public health and water pollution control agencies, or for purchase from the U.S. Department of Agriculture.

*Good Riddance.*—16-mm., color, sound, 30 minutes. Produced for the Ohio River Valley Water Sanitation Commission in Cincinnati. A documentary of the Ohio basin from Lake Chautauqua, N.Y., to Cairo, Ill., portraying traditional problems of water pollution along with new developments in control of pollution. Film is in two segments and can be shown as separate 14.5-minute features.

*Health and the Cycle of Water.*—16-mm., black-and-white, sound, 20 minutes. Produced for the cast-iron pipe industry. The film describes the water system of the fictitious town of Centerville. Animated diagrams are used to illustrate the town's water-treatment system.

*Pennies for Health.*—16-mm., black-and-white, sound, 15 minutes. Produced for the National Water Institute. Distributed through Modern TV, 927 19th Street, N.W., Washington 6, D.C. Summarizes the problem of a fixed water supply being expanded to meet increasing needs of both growing population and expanding industry.

*Progress in Action.*—16-mm., color, sound, 14 minutes. Produced for the Metropolitan Sewer District of St. Louis, Mo. Film tells the story of the overall sewer and water systems of the St. Louis metroplitan area.

*The River.*—16-mm., black-and-white, sound, 32 minutes. Produced in 1939 by the U.S. Department of Agriculture. A classic documentary of the Mississippi River, tracing its history and its tributaries; shows how erosion resulted from destruction of the forests; and emphasizes the need for conservation and rehabilitation.

*Water, Friend or Enemy.*—16-mm., color, animated sound, 10 minutes. Produced by Walt Disney. Film tells the story of water supply and protection for the individual home in a rural community where water sources are wells and springs.

*Water, Let's Keep It Clean.*—16-mm., color, sound, 20 minutes. Produced by the Department of Game and Fish, State of California, Sacramento. Calif. Contains colorful aerial views of effects of polluting outfalls on clean streams, plus vivid examples of destruction of aquatic life by chemicals poured into streams by industry.

# APPENDIX III

## Conference Participants

### A. CONFERENCE STEERING COMMITTEE

AMERICAN FEDERATION OF LABOR AND CONGRESS OF INDUSTRIAL ORGANIZATIONS—George H. Taylor

AMERICAN MUNICIPAL ASSOCIATION—Justus H. Fugate

AMERICAN PUBLIC HEALTH ASSOCIATION—Dwight F. Metzler

AMERICAN SOCIETY OF CIVIL ENGINEERS—Edward J. Cleary

AMERICAN WATER WORKS ASSOCIATION—Morrison B. Cunningham

ASSOCIATION OF STATE AND TERRITORIAL HEALTH OFFICERS—Russell E. Teague, M.D.

CHAMBER OF COMMERCE OF THE UNITED STATES—Felix E. Wormser; Alt., Richard W. Smith

CONFERENCE OF STATE SANITARY ENGINEERS—David B. Lee

CONSERVATION FOUNDATION—Roger Hale; Alts., Stephen W. Blodgett and W. D. Bowman

COUNCIL OF STATE GOVERNMENTS—Page L. Ingraham

EDISON ELECTRIC INSTITUTE—L. W. Cadwallader

ENGINEERS JOINT COUNCIL—Richard D. Hoak; Alt., John C. Geyer

GENERAL FEDERATION OF WOMEN'S CLUBS—Mrs. E. Lee Ozbirn

INTERNATIONAL ASSOCIATION OF GAME, FISH, AND CONSERVATION COMMISSIONERS—Harry Cornell

IZAAK WALTON LEAGUE OF AMERICA, INCORPORATED—Frank Gregg

LEAGUE OF WOMEN VOTERS OF THE UNITED STATES—Mrs. Arthur E. Whittemore

MANUFACTURING CHEMISTS' ASSOCIATION, INCORPORATED—Kenneth S. Watson; Alt., George E. Best

NATIONAL ASSOCIATION OF COUNTY OFFICIALS—Bernard F. Hillenbrand

NATIONAL ASSOCIATION OF MANUFACTURERS OF THE UNITED STATES OF AMERICA—Donald J. Hardenbrook; Alt., Daniel W. Cannon

NATIONAL ASSOCIATION OF SOIL CONSERVATION DISTRICTS—Gordon K. Zimmerman

NATIONAL COUNCIL FOR STREAM IMPROVEMENT—George E. Dyke

NATURAL RESOURCES COUNCIL OF AMERICA—C. R. Gutermuth

NATIONAL TECHNICAL TASK COMMITTEE ON INDUSTRIAL WASTES—A. J. Steffen; Alt., Leland C. Burroughs

NATIONAL WILDLIFE FEDERATION—Louis Clapper

RESOURCES FOR THE FUTURE, INCORPORATED—Irving K. Fox; Alt., Francis Christy

SOIL CONSERVATION SOCIETY OF AMERICA—H. Wayne Pritchard

STATE AND INTERSTATE WATER POLLUTION CONTROL ADMINISTRATORS—David F. Smallhorst; Alt., Milton P. Adams

UNITED STATES CONFERENCE OF MAYORS—Hon. Richardson Dilworth

WATER AND SEWAGE WORKS MANUFACTURERS ASSOCIATION, INCORPORATED—Harry E. Schlenz

WATER POLLUTION CONTROL ADVISORY BOARD—Seth Gordon and John S. Samson

WATER POLLUTION CONTROL FEDERATION—Ray E. Lawrence

WILDLIFE MANAGEMENT INSTITUTE—Dr. Ira N. Gabrielson

MEMBERS-AT-LARGE—Charles A. Bishop, Robert F. Boger, Dr. Gordon M. Fair, Blucher A. Poole, and J. V. Whitfield

## B. WATER POLLUTION CONTROL ADVISORY BOARD

### Chairman (ex officio)

BURNEY, DR. LEROY E., Surgeon General, Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C.

### Members

BORUFF, DR. CLAIR S., Technical Director, Hiram Walker and Sons, Incorporated, Peoria, Ill.

DALY, JOHN CHARLES, New York, N.Y.

GORDON, SETH, Conservation Consultant, California State Department of Fish and Game, Sacramento, Calif.

LONG, FRANK E., Chairman, Wyoming Stream Pollution Control Advisory Council, Buffalo, Wyo.

McCANN, HON. THOMAS A., Mayor, Fort Worth, Tex.

SAMSON, JOHN S., Chairman, Nebraska State Water Pollution Control Council, Omaha, Nebr.

TEAGUE, DR. RUSSELL E., Commissioner, Kentucky State Department of Health, Frankfort, Ky.

WISE, WILLIAM S., Director, Connecticut State Water Resources Commission, Hartford, Conn.

### Executive Secretary

AYERS, ROBERT C., Division of Water Supply and Pollution Control, Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C.

## C. PROGRAM PARTICIPANTS

### A

AANDAHL, HON. FRED G., Assistant Secretary for Water and Power Development, U.S. Department of the Interior, Washington, D.C.

ACKERMAN, DR. E. A., Executive Officer, Carnegie Institution of Washington, Washington, D.C.

ADAMS, MILTON P., Executive Secretary, Michigan State Water Resources Commission, Lansing, Mich.

AYERS, ROBERT C., Executive Secretary, Water Pollution Control Advisory Board, Public Health Service, Washington, D.C.

### B

BANKS, HARVEY O., Director, California State Department of Water Resources, Sacramento, Calif.

BARNHILL, JOHN T., Program Officer, Division of Water Supply and Pollution Control, Public Health Service, Washington, D.C.

BERGER, BERNARD B., Chief, Research Branch, Division of Water Supply and Pollution Control, Public Health Service, Cincinnati, Ohio

BEST, GEORGE E., Secretary, Water Pollution Abatement Committee, Manufacturing Chemists' Association, Washington, D.C.

BIEMILLER, ANDREW J., Director, Department of Legislation, American Federation of Labor-Congress of Industrial Organizations, Washington, D.C.

BISHOP, DR. CHARLES A., Director, Chemical Process Development, U.S. Steel Corporation, Pittsburgh, Pa.

BLATNIK, HON. JOHN A., Representative, 8th District, Minnesota; Chairman, Subcommittee on Rivers and Harbors, House Public Works Committee, Washington, D.C.

BLODGETT, STEPHEN W., Secretary, The Conservation Foundation, New York, N.Y.

BOGER, ROBERT F., Publisher, *Engineering News-Record*, New York, N.Y.

BORUFF, DR. CLAIR S., Technical Director, Hiram Walker and Sons, Inc., Peoria, Ill., Member, Water Pollution Control Advisory Board

BOWMAN, W. D., Associate Director of Research, The Conservation Foundation, New York, N.Y.

BRANDT, DR. KARL, Member, Council of Economic Advisers, Washington, D.C.

BROWN, CARL B., Watershed Program Specialist, Office of the Assistant Administrator for Watersheds, Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.

BURGESS, IAN K., Conference Staff, Engineering, Public Health Service, Washington, D.C.

BURNEY, DR. LEROY E., Surgeon General, Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C.

BURROUGHS, LELAND C., Assistant to the Vice President—Manufacturing, Shell Oil Company, New York, N.Y.

BUTRICO, FRANK A., Executive Secretary, National Conference on Water Pollution, Public Health Service, Washington, D.C.

## C

CADWALLADER, L. W., Vice President, Potomac Electric Power Company, Washington, D.C.

CANNAN, DR. R. KEITH, Chairman, Division of Medical Sciences, National Research Council, Washington, D.C.

CANNON, DANIEL W., Conservation Committee, National Association of Manufacturers, New York, N.Y.

CASE, HON. FRANCIS, United States Senator, South Dakota; Member, Senate Select Committee on National Water Resources, United States Senate, Washington, D.C.

CHRISTY, FRANCIS, Research Associate, Resources For The Future, Inc., Washington, D.C.

CLAPPER, LOUIS, Acting Conservation Director, National Wildlife Federation, Washington, D.C.

CLEARY, EDWARD J., Executive Director and Chief Engineer, Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio

CORNELL, HARRY, Chief, Fish Division, North Carolina Wildlife Resources Commission, Raleigh, N.C.

COTTAM, DR. CLARENCE, Welder Wildlife Foundation, Sinton, Tex.

CRAMER, HON. WILLIAM C., Representative, 1st District, Florida; Member, Subcommittee on Rivers and Harbors, House Public Works Committee, Washington, D.C.

CUNNINGHAM, MORRISON B., Superintendent and Engineer, City Water Department, Oklahoma City, Okla.

CURLEY, FRANK E., Partner, Hawkins, Delafield, and Wood, Municipal Bond Attorneys, New York, N.Y.

CURRAN, JOHN, Legislative Representative, American Federation of Labor-Congress of Industrial Organizations, Washington, D.C.

## D

DALY, JOHN CHARLES, Member, Water Pollution Control Advisory Board, New York, N.Y.

DEAN, DR. L. A., Research Investigations Leader, Soil and Water Conservation Research Division, U.S. Department of Agriculture, Washington, D.C.

DILWORTH, Hon. RICHARDSON, Mayor, Philadelphia, Pa.

DURHAM, CHARLES J., Conference Staff, Information, Public Health Service, Washington, D.C.

DYKE, GEORGE E., Chairman, Board of Governors, National Council for Stream Improvement, New York, N.Y.

## E

ELIASSEN, DR. ROLF, Professor of Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

ENGLE, HON. CLAIR, United States Senator, California; Member, Senate Select Committee on National Resources, United States Senate, Washington, D.C.

ENGLER, HERSHEL, Conference Staff, Engineering, Public Health Service, Washington, D.C.

## F

FABER, HARRY A., Research Grants Administrator, Division of Water Supply and Pollution Control, Public Health Service, Washington, D.C.

FAIR, DR. GORDON M., Professor of Sanitary Engineering, Harvard University, Cambridge, Mass.

FINLEY, STUART, Documentary Film Producer, Washington, D.C.

FLANNERY, JAMES J., Economist, Technical Services Branch, Division of Water Supply and Pollution Control, Public Health Service, Washington, D.C.

FLEMMING, HON. ARTHUR S., Secretary of Health, Education, and Welfare, Washington, D.C.

FORSTER, ALBERT E., President, Hercules Powder Company, Wilmington, Del.

FORSYTHE, ROBERT A., Assistant Secretary for Legislation, U.S. Department of Health, Education, and Welfare, Washington, D.C.

FOX, IRVING K., Vice President, Resources For The Future, Inc., Washington, D.C.

FUGATE, JUSTUS H., City Commissioner, Wichita Kans.

## G

GABRIELSON, DR. IRA N., President, Wildlife Management Institute, Washington, D.C.

GEYER, DR. JOHN C., Chairman, Department of Sanitary Engineering and Water Resources, The Johns Hopkins University, Baltimore, Md.

GILBERTSON,WESLEY E., Chief, Division of Engineering Services, Public Health Service, Washington, D.C.

GILL, JAMES M., Plant Manager, Ethyl Corporation, Pittsburg, Calif.

GLEASON, M. JAMES, Multnomah County Commissioner, Portland, Oreg.

GORDON, SETH, Conservation Consultant, California State Department of Fish and Game, Sacramento, Calif.; Member, Water Pollution Control Advisory Board.

GREEN, RICHARD S., Chief, Basic Data Branch, Division of Water Supply and Pollution Control, Public Health Service, Washington, D.C.

GREENE, EDWARD A., Conference Staff, Information, Public Health Service, Washington, D.C.

GREGG, FRANK, Executive Director, Izaak Walton League of America, Inc., Glenview, Ill.

GUTERMUTH, C. R., Natural Resources Council of America, Washington, D.C.

## H

HALE, ROGER, Vice President, The Conservation Foundation, New York, N.Y.

HALL, WARNER W., Conference Staff, Information, Washington, D.C.

HARDENBROOK, DONALD J., Chairman, Conservation and Management of Natural Resources Committee, National Association of Manufacturers, New York, N.Y.

HARLAN, JAMES R., Conservation Consultant, Division of Water Supply and Pollution Control, Public Health Service, Washington, D.C.

HAZEN, RICHARD, Partner, Hazen & Sawyer, Consulting Engineers, New York, N.Y.

HILLENBRAND, BERNARD F., Executive Director, National Association of County Officials, Washington, D.C.

HOAK, DR. RICHARD D., Senior Fellow, Mellon Institute, Pittsburgh, Pa.

HOLLIS, MARK D., Assistant Surgeon General and Chief Engineer, Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C.

HOWELLS, DAVID H., Chief, Construction Grants Branch, Division of Water Supply and Pollution Control, Public Health Service, Washington, D.C.

HUBBARD, EARLE C., Director and Executive Secretary, North Carolina State Stream Sanitation Committee, Raleigh, N.C.

HUTCHINGS, ROBERT S., Conference Staff, Information, Public Health Service, Washington, D.C.

## I

INGRAHAM, PAGE L., Direcor of Research, The Council of State Governments, Chicago, Ill.

## K

KEHOE, DR. ROBERT A., Director, The Kettering Laboratory of the College of Medicine, University of Cincinnati, Cincinnati, Ohio

KERR, HON. ROBERT S., United States Senator, Oklahoma; Chairman, Senate Select Committee on National Water Resources, United States Senate, Washington, D.C.

KLASSEN, CLARENCE W., Director, Division of Sanitary Engineering, Illinois State Department of Public Health, Springfield, Ill.

KRAUSE, KEITH S., Chief, Technical Services Branch, Division of Water Supply and Pollution Control, Public Health Service, Washington, D.C.

## L

LAWRENCE, RAY E., President, Water Pollution Control Federation; Partner, Black & Veatch, Consulting Engineers, Kansas City, Mo.

LEAKE, DR. CHAUNCEY D., Dean and Professor of Pharmacology, College of Medicine, Ohio State University, Columbus, Ohio

LEE, DAVID B., Director, Bureau of Sanitary Engineering, Florida State Board of Health, Jacksonville, Fla.

LIGHT, DR. ISRAEL, Conference Staff, Information, Washington, D.C.

LONG, FRANK E., Chairman, Wyoming Stream Pollution Control Advisory Council, Buffalo, Wyoming; Member, Water Pollution Control Advisory Board

LYNCH, R. G., Columnist, *Milwaukee Journal*, Milwaukee, Wis.

### M

McCALLUM, GORDON E., Chief, Division of Water Supply and Pollution Control, Public Health Service, Washington, D.C.

McCANN, HON. THOMAS A., Mayor of Fort Worth; Member, Water Pollution Control Advisory Board; and Member, U.S. Conference of Mayors; Fort Worth, Tex.

MASON, KARL M., Director, Bureau of Environmental Health, Pennsylvania State Department of Health, Harrisburg, Pa.

METZLER, DWIGHT F., Director, Division of Sanitation, Kansas State Board of Health; Chairman, Conference of State Sanitary Engineers, Topeka, Kans.

### O

OZBIRN, MRS. E. LEE, President, General Federation of Women's Clubs, Washington, D.C.

### P

PALANGE, RALPH C., Conference Staff, Engineering, Public Health Service, Washington, D.C.

PARTAIN, LLOYD E., Curtis Publishing Company, Philadelphia, Pa.

PASEK, LEONARD, Assistant to the President, Kimberly-Clark Corporation, Neenah, Wis.

PEARSON, DR. ERMAN A., Associate Professor of Sanitary Engineering, University of California, Berkeley, Calif.

POOLE, BLUCHER A., Technical Secretary, Indiana State Stream Pollution Control Board, Indianapolis, Ind.

POWERS, THOMAS J., Consulting Director, Dow Industrial Service Division, Dow Chemical Company, Cleveland, Ohio

PRITCHARD, H. WAYNE, Executive Secretary, The Soil Conservation Society of America, Des Moines, Iowa

PUTNEY, BRYANT, Conference Staff, Information, Public Health Service, Washington, D.C.

### R

RICHARDS, ROLAND, Conference Staff, Engineer, Washington, D.C.

ROHLICH, DR. GERARD A., Professor of Sanitary Engineering, University of Wisconsin, Madison, Wis.

### S

SAMSON, JOHN S., Chairman, Nebraska State Water Pollution Control Council, Omaha, Nebr.; Member Water Pollution Control Advisory Board.

SANDERS, RICHARD T., Director, Division of Legislative Drafting and Codification of Statutes, North Carolina State Department of Justice, Raleigh, N.C.

SCHAD, THEODORE M., Staff Director, Senate Select Committee on National Water Resources, United States Senate, Washington, D.C.

SCHLENZ, HARRY E., President, Pacific Flush Tank Company; Vice President, Water Pollution Control Federation, Chicago, Ill.

SMALLHORST, DAVID F., Director, Division of Water Pollution, State Department of Health, Austin, Tex.

SMITH, RICHARD W., Manager, Natural Resources Department, United States Chamber of Commerce, Washington, D.C.

STEFFEN, A. J., Chairman, National Technical Task Committee on Industrial Wastes, Chicago, Ill.

STEIN, MURRAY, Chief, Enforcement Branch, Division of Water Supply and Pollution Control, Public Health Service, Washington, D.C.

SVORE, JEROME H., Regional Program Director, U.S. Department of Health, Education, and Welfare, Region VII, Division of Water Supply and Pollution Control, Dallas, Tex.

### T

TAYLOR, GEORGE H., Department of Research, American Federation of Labor-Congress of Industrial Organizations, Washington D.C.

TEAGUE, DR. RUSSELL E., Commissioner, Kentucky State Department of Health, Frankfort, Ky.; Member, Water Pollution Control Advisory Board.

TOWNE, W. W., Chief, Field Operations Section, Technical Services Branch, Division of Water Supply and Pollution Control, Cincinnati, Ohio

### W

WARRICK, LOUIS F., Executive Secretary, National Technical Task Committee on Industrial Wastes, Washington, D.C.

WATSON, KENNETH S., Consultant, Water Management and Water Control, General Electric Company, Schenectady, N.Y.

WEBER, EUGENE W., Special Assistant to the Director of Civil Works, Office of the Chief of Engineers, Department of the Army, Washington, D.C.

WHITE, DR. GILBERT F., Professor of Geography, University of Chicago, Chicago, Ill.

WHITFIELD, J. V., Chairman, State Stream Sanitation Committee, North Carolina Department of Water Resources, Raleigh, N.C.

WHITTEMORE, MRS. ARTHUR E., Chairman, Water Resources Committee and Director, League of Women Voters of the United States, Hingham, Mass.

WILSON, CHESTER S., Attorney, Formerly Commissioner, Minnesota State Department of Conservation, Stillwater, Minn.

WISE, WILLIAM S., Director, Connecticut State Water Resources Commission, Hartford, Conn.; Member, Water Pollution Control Advisory Board

WOLMAN, DR. ABEL, Professor of Sanitary Engineering, The Johns Hopkins University, Baltimore, Md.

WOODRUFF, JAMES W., JR., Chairman, U.S. Study Commission, Southeast River Basins, Atlanta, Ga.

WORMSER, FELIX E., Consulting Mining Engineer, Greenwich, Conn.

### Z

ZAPP, DR. JOHN A., Director, Haskell Laboratory, E. I. du Pont de Nemours, Newark, Del.

ZIMMERMAN, GORDON K., Executive Secretary, National Association of Soil Conservation Districts, Washington, D.C.

○